



## CHAPTER 3. AFFECTED ENVIRONMENT

This chapter describes the existing environmental and socioeconomic characteristics of the Savannah River Site (SRS) and nearby region that could be affected by the proposed action or its alternatives. The data presented in this chapter are required to assess the consequences of the proposed action and its alternatives.

### 3.1 Introduction

SRS is located in southwestern South Carolina adjacent to the Savannah River, which forms the boundary between South Carolina and Georgia. It encompasses approximately 800 square kilometers (300 square miles) within the Atlantic Coastal Plain physiographic province. SRS is approximately 40 kilometers (25 miles) southeast of Augusta, Georgia, and 32 kilometers (20 miles) south of Aiken, South Carolina. Figure 3-1 shows the location of SRS within the South Carolina-Georgia region.

SRS is a controlled area with limited public access. Through traffic is allowed only on SC Highway 125, U.S. Highway 278, SRS Road 1, and CSX railroad corridors (Figure 3-1). Figure 3-2 shows SRS areas and facilities, which include five nuclear production reactors (C-, K-, L-, P-, and R-Reactors); a nuclear target and fuel fabrication facility (M-Area), which assembled the targets and fuel that went into the reactors; two chemical separations areas (F- and H-Areas), which processed irradiated targets and fuel assemblies to separate and recover various isotopes and which contain the liquid high-level radioactive waste tank farms; a waste vitrification facility (S-Area), which vitrifies liquid high-level radioactive waste; a saltstone facility (Z- Area), which solidifies low-level radioactive sludge into a cement-like matrix; N-Area, where some wastes are stored; E-Area, which includes waste treatment, storage, and disposal facilities; and various administrative, support, and research facilities. These facilities have generated a variety of liquid high-level radioactive, low-level radioactive, hazardous, mixed (hazardous and radioactive), and transuranic wastes. Section 3.13 provides photographs and descriptions of specific waste management facilities. Section 4.4.15 and Appendix B also describe facilities at SRS.

**Figure 3-1. Savannah River Site.**

**Figure 3-2. SRS areas and facilities.**

### 3.2 Geologic Resources

#### 3.2.1 SOILS AND TOPOGRAPHY

SRS is located on the Aiken Plateau of the Upper Atlantic Coastal Plain physiographic province about 40 kilometers (25 miles) southeast of the Fall Line that separates the Atlantic Coastal Plain from the Piedmont physiographic province (Figure 3-3). The Aiken Plateau is highly dissected and consists of broad, flat areas between streams and narrow, steep-sided valleys. It slopes from an elevation of approximately 200 meters (650 feet) at the Fall Line to an elevation of about 75 meters (250 feet) on the southeast edge of the plateau. Because of SRS's proximity to the Piedmont province, it is somewhat more hilly than the near-coastal areas, with onsite elevations ranging from 27 to 128 meters (90 to 420 feet) above sea level. Relief on the Aiken Plateau is as much as 90 meters (300 feet) locally. The plateau is generally well drained, although small poorly drained depressions do occur. The *Final Environmental Impact Statement, Continued Operation of K-, L-, and P-Reactors, Savannah River Site, Aiken, South Carolina* (DOE 1990) contains a complete description of the geologic setting and the stratigraphic sequences at SRS.

Previously disturbed soils are mostly well drained and were taken from excavated areas, borrow pits, and other areas where major land-shaping or grading activities have occurred. These soils are found beside and under streets, sidewalks, buildings, parking lots, and other structures. Much of the soil in the existing waste management areas has been moved, so soil properties can vary within a few meters. Slopes of soils generally range from 0 to 10 percent and have a moderate erosion hazard. These disturbed soils range from a consistency of sand to clay, depending on the source of the soil material (USDA 1990).

Undisturbed soils at SRS generally consist of sandy surface layers above a subsoil containing a mixture of sand, silt, and clay. These soils are gently sloping to moderately steep (0 to 10 percent grade) and have a slight erosion hazard (USDA 1990). Some soils on uplands are nearly level, and those on bottomlands along the major streams are level. Soils in small, narrow drainage valleys are steep. Most of the upland soils are well drained to excessively drained. The well-drained soils have a thick, sandy surface layer that extends to a depth of 2 meters (7 feet) or more in some areas. The soils on bottomlands range from well drained to very poorly drained. Some soils on the abrupt slope breaks have a dense, brittle subsoil.

**Figure 3-3. General location of the SRS and its relationship to physiographic provinces of the southeastern United States.**

### 3.2.2 Geologic Structures

Several fault systems occur offsite, northwest of the Fall Line. DOE (1990) contains a detailed discussion of these offsite geologic features. A recent study (Stephenson and Stieve 1992) identified six faults under SRS: Pen Branch, Steel Creek, Advanced Tactical Training Area (ATTA), Crackerneck, Ellenton, and Upper Three Runs Faults. Identification of faults is important because earthquakes can occur along these faults. The location of faults must be considered when siting hazardous waste management facilities. South Carolina Department of Health and Environmental Control (SCDHEC) regulations specify a setback distance of at least 61 meters (200 feet) from a fault where displacement during the Holocene Epoch (approximately 35,000 years ago to the present) has occurred. None of the waste management areas occur within 61 meters (200 feet) of any faults, nor is there evidence that any of the identified faults have moved in the last 35,000 years. Based on information developed to date, none of the faults discussed in this section are considered "capable," as defined by the Nuclear Regulatory Commission in 10 CFR 100, Appendix A. The capability of a

fault is determined by several criteria, one of which is whether the fault has moved at or near the ground surface within the past 35,000 years.

Several subsurface investigations conducted on SRS waste management areas encountered soft sediments classified as calcareous sands. These sands contain calcium carbonate (calcite), which can be dissolved by water. The calcareous sands were encountered in borings in S-, H-, and Z-Areas between 33 and 45 meters (110 to 150 feet) below ground surface. Preliminary information indicates that these calcareous zones are not continuous over large areas, nor are they very thick. If the calcareous material dissolved, possible underground subsidence could result in settling at the ground surface. No such settling has been reported at any of the waste management facilities; however, the U.S. Department of Energy (DOE) is currently investigating potential impacts of subsidence.

### 3.2.3 SeisMICITY

Two major earthquakes have occurred within 300 kilometers (186 miles) of SRS. The first was the Charleston, South Carolina, earthquake of 1886, which had an estimated Richter scale magnitude of 6.8 and occurred approximately 145 kilometers (90 miles) from SRS. The SRS area experienced an estimated peak horizontal acceleration of 10 percent of gravity (0.10g) during this earthquake (URS/Blume 1982). The second major earthquake was the Union County, South Carolina, earthquake of 1913, which had an estimated Richter scale magnitude of 6.0 and occurred about 160 kilometers (99 miles) from SRS (Bollinger 1973). Because these earthquakes have not been conclusively associated with a specific fault, researchers cannot determine the amount of displacement resulting from them.

Two earthquakes occurred during recent years inside the SRS boundary. On June 8, 1985, an earthquake with a local Richter scale magnitude of 2.6 and a focal depth of 0.96 kilometer (0.59 mile) occurred at SRS. The epicenter was west of C- and K-Areas (Figure 3-4). The acceleration produced by the earthquake did not activate seismic monitoring instruments in the reactor areas (which have detection limits of 0.002g). On August 5, 1988, an earthquake with a local Richter scale magnitude of 2.0 and a focal depth of 2.68 kilometers (1.66 miles) occurred at SRS. Its epicenter was northeast of K-Area (Figure 3-4). The seismic alarms in SRS facilities were not triggered. Existing information does not conclusively correlate the two earthquakes with any of the known faults on the site.

A report on the August 1988 earthquake (Stephenson 1988) reviewed the latest earthquake history. The report predicts a recurrence rate of 1 earthquake per year at a Richter scale magnitude of 2.0 in the southeast Coastal Plain. However, the report also notes that historic data that can be used to accurately calculate recurrence rates are sparse.

A Richter scale magnitude 3.2 earthquake occurred on August 8, 1993, approximately 16 kilometers (10 miles) east of the city of Aiken near Couchton, South Carolina. Residents reported feeling this earthquake in Aiken, New Ellenton (immediately north of SRS), and North Augusta, South Carolina [approximately 40 kilometers (25 miles) northwest of SRS]. Although detected by SRS instruments, no seismic alarms were triggered.

The current design basis earthquake that nuclear safety-related facilities are engineered to withstand is one that would produce a horizontal peak ground acceleration of 20 percent of gravity (0.2g). Based on current estimates, an earthquake of this magnitude or greater can be expected to occur about

once every 5,000 years.

### 3.3 Groundwater

This section updates the detailed water resources information provided in the *Final Environmental Impact Statement, Waste Management Activities for Groundwater Protection, Savannah River Plant, Aiken, South Carolina* (DOE 1987) and in DOE (1990), and incorporates the latest aquifer terminology used at SRS.

#### 3.3.1 Aquifer Units

The most important hydrologic system underlying SRS occurs above the Piedmont hydrogeologic province in the Coastal Plain sediments, in which groundwater flows through porous sands and clays.

#### Figure 3-4. Geologic fault of SRS.

Figure 3-5 names the geologic formations based on the physical character of the rocks (lithostratigraphy) and the corresponding names used to identify their water-bearing properties (hydrostratigraphy); this figure also identifies the shallow, intermediate, and deep aquifers. This eis uses depth-based identification to simplify discussions of groundwater resources and consequences. More detailed discussions of SRS groundwater features are available in DOE (1987) and DOE (1990).

#### 3.3.2 GROUNDWATER FLOW

Groundwater beneath SRS flows at rates ranging from a few centimeters (inches) per year to several hundred meters (feet) per year toward streams and swamps on the site and into the Savannah River.

At SRS, groundwater movement is controlled by the depths of the incisions of creeks and streams where water discharges to the surface. The valleys of the smaller perennial streams collect discharge from the shallow aquifers. Groundwater in the intermediate aquifer flows to Upper Three Runs or to the Savannah River. Water in the deep aquifer beneath SRS flows toward the Savannah River or southeast toward the coast. Beneath some of SRS, groundwater flow is predominantly downward from the upper to the lower parts of the shallow aquifer. This downward flow occurs under A-, M-, L-, and P-Areas. In other areas, groundwater flow is upward, from the lower to the upper parts of the shallow aquifer and from the deep aquifer to the lower part of the shallow aquifer. This upward flow occurs, for example, in the separations (F and H) areas and around C-Area. The upward flow increases near Upper Three Runs.

This section and Section 3.3.3 present groundwater flow and quality, respectively, associated with waste units with known or potential releases to the subsurface. Waste units discussed in these sections are listed in the SRS Federal Facility Agreement (EPA 1993a); Appendix G.1 of this eis (Resource Conservation and Recovery Act (RCRA)/Comprehensive Environmental Response,

Compensation and Liability Act Units List) - sites with known releases; Appendix G.2 of this eis (RCRA Regulated Units) or Appendix G.3 of this eis (Site Evaluation List) - sites with potential releases to be investigated. Table 3-1 lists these waste units by area and the known contaminants for each area (or group of waste units). Refer to Figure 3-6 for the location of these units.

Some SRS facilities that will be investigated in the future for potential groundwater remediation (and the horizontal flow directions of the groundwater beneath them) include the M-Area Metallurgical Laboratory (horizontal flow to the west-northwest in the shallow aquifer and to the south toward Upper Three Runs in the intermediate aquifer); K-Area seepage basin (flow to the southwest toward Indian Grave Branch); L-Area seepage basin (flow toward Pen Branch and L-Lake); and the P-Area seepage basin (flow toward Steel Creek). F- and H-Areas and vicinity are on a surface and groundwater divide; shallow groundwater flows toward either Upper Three Runs or Fourmile Branch.

For further technical discussions of groundwater flow beneath waste units of interest for this eis, as well as beneath SRS in general, for the relationships of groundwater flow between the three main aquifers, and for values for aquifer properties that are useful in analysis of groundwater flow and consequences, see DOE (1987, 1990).

**Figure 3-5. Comparison of lithostratigraphy, 1982 hydrostratigraphic nomenclature, and current hydrostratigraphy for the SRS region.**

**Table 3-1. Waste units associated with known or potential releases to the groundwater at SRS.a**

Area	Waste Units	Contaminants
A- and M-Areas	<ul style="list-style-type: none"> <li>• M-Area Hazardous Waste Management Facility</li> <li>• Metallurgical Laboratory Seepage Basin</li> <li>• Savannah River Technology Center (SRTC) Seepage Basins</li> </ul>	Volatile organic compounds (VOCs), radionuclides, metals, nitrates
Reactor Areas	<ul style="list-style-type: none"> <li>• Reactor Seepage Basins</li> <li>• Acid/Caustic Basins</li> <li>• K-Area Retention Basin</li> <li>• L-Area Oil/Chemical Basin</li> </ul>	C-, K-, L-, and P-Areas: tritium, other radionuclides, metals, VOCs R-Area: radionuclides, cadmium
E-Area, Separations (F and H) Areas	<ul style="list-style-type: none"> <li>• Burial Ground Complex</li> <li>• Mixed Waste Storage</li> <li>• F/H Seepage Basins</li> <li>• F/H Tank Farms</li> <li>• H-Area Retention Basin</li> </ul>	Tritium, other radionuclides, metals, nitrate, sulfate, VOCs
G-Area	<ul style="list-style-type: none"> <li>• Sanitary Landfill</li> </ul>	Tritium, lead, VOCs

TNX	<ul style="list-style-type: none"> <li>• Seepage Basins</li> <li>• Burying Ground</li> </ul>	Radionuclides, VOCs, nitrate
D-Area	<ul style="list-style-type: none"> <li>• Oil Disposal Basin</li> </ul>	Metals, radionuclides, VOCs, sulfate

a. Source: Modified from Arnett, Karapatakis, and Mamatey (1993).

### 3.3.3 GROUNDWATER QUALITY

Groundwater of excellent quality is abundant in this region of South Carolina from many local aquifers. The water in Coastal Plain sediments is generally of good quality and suitable for municipal and industrial use with minimum treatment. The water is generally soft, slightly acidic (pH of 4.9 to 7.7), and low in dissolved and suspended solids. High dissolved iron concentrations occur in some aquifers. Groundwater is the only source of domestic water at SRS and where necessary, it is treated to raise the pH and remove the iron.

#### **Figure 3-6.**

Industrial solvents, metals, tritium, and other constituents used or generated at SRS have contaminated the shallow aquifers beneath 5 to 10 percent of SRS (Arnett, Karapatakis, Mamatey 1993). Localized contamination of groundwater in the deep aquifer was found in the early 1980s beneath M-Area. Low concentrations of trichloroethylene (11.7 milligrams per liter) have been detected in water from a production well in M-Area. Similarly, low trichloroethylene values have been detected in a few other wells used for process water (du Pont 1983). Groundwater contamination has not been detected outside SRS boundaries. Figure 3-6 shows (1) the locations of facilities where SRS monitors groundwater, (2) areas with constituents that exceeded drinking water standards (40 CFR Part 141) in 1992, and (3) waste units associated with known or potential releases that may require groundwater remediation. Most contaminated groundwater at SRS occurs beneath a few facilities; contaminants reflect the operations and chemical processes performed at those facilities. For example, contaminants in the groundwater beneath A- and M-Areas include chlorinated volatile organic compounds, radionuclides, metals, and nitrate. At F- and H-Areas, contaminants in the groundwater include tritium and other radionuclides, metals, nitrate, chlorinated volatile organic compounds, and sulfate. At the reactors (C-, K-, L-, and P-Areas), tritium, other radionuclides, and lead are present in the groundwater. At D-Area, contaminants in the groundwater include volatile organic compounds, chromium, nickel, lead, zinc, iron, sulfate, and tritium. A recent SRS annual environmental report (Arnett, Karapatakis, and Mamatey 1993) presents specific groundwater data from more than 1,600 monitoring wells at SRS, including approximately 120 wells in A- and M-Areas, 218 plume-definition wells in these areas, 8 wells in the areas of the reactors of interest, and more than 350 wells in F- and H-Areas.

After the discovery in 1981 that groundwater beneath A- and M-Areas was contaminated with volatile organic compounds, SRS established an assessment program to define the extent and migration rate of the contamination. A groundwater extraction system was installed in 1983 and modified in 1985. It consists of 11 wells which pump more than 1,890 liters (500 gallons) per minute

from the lower section of the shallow aquifer and an air stripper process which removes the volatile organic compounds. The treated waste is discharged to Tims Branch and Upper Three Runs through permitted outfalls.

### **3.3.4 GROUNDWATER USE**

Groundwater is a domestic, municipal, and industrial water source throughout the Upper Coastal Plain. Most municipal and industrial water supplies in Aiken County are from the deep aquifers. Domestic water supplies are primarily from the intermediate and shallow aquifers. In Barnwell and Allendale Counties, the intermediate zone and overlying units that thicken to the southeast supply some municipal users. At SRS, most groundwater production is from the deep aquifer, with a few lower-capacity wells pumping from the intermediate zone. Every major operating area at SRS has groundwater-producing wells. Total groundwater production at SRS is from 34,000 to 45,000 cubic meters (9 to 12 million gallons) per day, similar to the volume pumped for industrial and municipal production within 16 kilometers (10 miles) of SRS.

DOE has identified 56 major municipal, industrial, and agricultural groundwater users within 32 kilometers (20 miles) of the center of SRS (DOE 1987). The total amount pumped by these users, excluding SRS, is about 135,000 cubic meters (36 million gallons) per day.

## **3.4 Surface Water**

### **3.4.1 SAVANNAH RIVER**

The Savannah River is the southwestern border of SRS for about 32 kilometers (20 miles). SRS is approximately 260 river kilometers (160 river miles) from the Atlantic Ocean. At SRS, river flow averages about 283 cubic meters (10,000 cubic feet) per second. Three large upstream reservoirs, Hartwell, Richard B. Russell, and Strom Thurmond/Clarks Hill, moderate the effects of droughts and the impacts of low flows on downstream water quality and fish and wildlife resources in the river.

The Savannah River, which forms the boundary between Georgia and South Carolina, supplies potable water to several municipal users. Immediately upstream of SRS, the river supplies domestic and industrial water to Augusta, Georgia, and North Augusta, South Carolina. The river also receives sewage treatment plant effluents from Augusta, Georgia; North Augusta, Aiken, and Horse Creek Valley, South Carolina; and from a variety of SRS operations through permitted stream discharges. Approximately 203 river kilometers (126 river miles) downstream of SRS, the river supplies domestic and industrial water for the Port Wentworth (Savannah, Georgia) water treatment plant at river kilometer 47 (river mile 29) and for Beaufort and Jasper Counties in South Carolina at river kilometer 63 (river mile 39.2). In addition, Georgia Power's Vogtle Electric Generating Plant withdraws an average of 1.3 cubic meters (46 cubic feet) per second for cooling and returns an average of 0.35 cubic meters (12 cubic feet) per second. Also, the South Carolina Electric and Gas Company's Urquhart Steam Generating Station at Beech Island, South Carolina, withdraws approximately 7.4 cubic meters (261 cubic feet) per second of once-through cooling water.

In 1992, SCDHEC changed the classification of the Savannah River and the SRS streams from "Class B waters" to "Freshwaters." The definitions of Class B waters and Freshwaters are the same, but the Freshwaters classification imposes a more stringent set of water quality standards. Table 3-2 provides data on water quality in the Savannah River upstream and downstream of SRS during 1992. Comparison of the upstream and downstream concentrations shows little impact from SRS discharges on the water quality of the Savannah River, except for an increase in the tritium concentration. Constituents of SRS discharges are within the guidelines for drinking water established by the U.S. Environmental Protection Agency (EPA), SCDHEC, and DOE.

### 3.4.2 SRS STReAMS

This section describes the pertinent physical and hydrological properties of the six SRS tributaries that drain to the Savannah River.

The five tributaries which discharge directly to the river from SRS are Upper Three Runs, Beaver Dam Creek, Fourmile Branch, Steel Creek, and Lower Three Runs (Figure 3-7). A sixth stream, Pen Branch, does not flow directly into the Savannah River but joins Steel Creek in the Savannah River floodplain swamp. These tributaries drain all of SRS with the exception of a small area on the northeast side. No development occurs in this area of SRS, which drains to an unnamed tributary of Rosemary Branch, a tributary of the Salkehatchie River. Each of these six streams originates on the Aiken Plateau in the Coastal Plain and descends 15 to 60 meters (50 to 200 feet) before discharging into the river. The streams, which historically have received varying amounts of effluent from SRS operations, are not commercial sources of water. The natural flow of SRS streams ranges from 0.3 cubic meter (11 cubic feet) per second in smaller streams such as Indian Grave Branch, a tributary to Pen Branch, to 6.8 cubic meters (240 cubic feet) per second in Upper Three Runs (Wike et al. 1994).

Upper Three Runs is a large, cool [annual maximum temperature of 26.1°C (79°F)] blackwater stream that discharges to the Savannah River in the northern part of SRS. It drains an area approximately 545 square kilometers (210 square miles), and during water year 1991 (a water year is October through September) had a mean discharge of 6.8 cubic meters (239 cubic feet) per second at the mouth of the creek (Wike et al. 1994). The 7-day, 10-year low flow (the lowest flow expected in any consecutive 7 days in any 10 years) is 2.8 cubic meters (100 cubic feet) per second. Upper Three Runs is approximately 40 kilometers (25 miles) long, with its lower 28 kilometers (17 miles) within the boundaries of the SRS. This creek receives more water from underground sources than other SRS streams and, therefore, has lower dissolved solids, hardness, and pH values. Upper Three Runs is the only major tributary on SRS that has not received thermal discharges. It receives surface water runoff and water from permitted discharges in A-, E-, F-, H-, M-, S-, and Z-Areas. Table 3-3 presents maximum and minimum values for water quality parameters for Upper Three Runs for 1993. Water quality parameters for other onsite streams are presented in Appendix E.

#### **Figure 3-7. Major stream systems and facilities at the Savannah River Site.**

Beaver Dam Creek is approximately 5 kilometers (3.1 miles) long and drains approximately 2.2 square kilometers (approximately 1 square mile). Beaver Dam Creek originates at the effluent canal of D-Area and flows south, parallel to Fourmile Branch. Some of the discharges of Fourmile Branch and Beaver Dam Creek mix in the Savannah River floodplain swamp before entering the Savannah

River. Prior to SRS operations, Beaver Dam Creek had only intermittent or low flow. It has received thermal effluents since 1952 as a result of the cooling water operations from the heavy water production facility (shut down in 1982) and a coal-fired power plant in D-Area. Currently, Beaver Dam Creek receives condenser cooling water from the coal-fired power plant, neutralization wastewater, sanitary wastewater treatment effluent, ash basin effluent waters, and various laboratory wastewaters. In water year 1991, the mean flow rate for Beaver Dam Creek taken approximately 1 kilometer (0.6 miles) south of D-Area was 2.6 cubic meters (93 cubic feet) per second. The mean temperature found during the comprehensive cooling water study (conducted between 1983 and 1985) (Gladden et al. 1985) was 25°C (77°F), with a maximum temperature of 34°C (93°F) (Wike et al. 1994). As required by a Record of Decision (DOE 1988), water from the Savannah River is added to the D-Area powerhouse condenser discharges during the summer months to maintain the temperature of the stream below 32.2°C (90°F) (DOE 1987).

Fourmile Branch is a blackwater stream that previous SRS operations have affected. It originates near the center of SRS and follows a southwesterly route for approximately 24 kilometers (15 miles). It drains an area of about 57 square kilometers (21 square miles), receiving effluents from F- and H-Areas. It received C- Reactor effluent until C-Reactor was placed on shutdown status in 1987; however, thermal discharges ceased in 1985. When C-Reactor was operating, its discharge resulted in water temperatures in excess of 60°C (140°F). Since the shutdown of C-Reactor, the maximum recorded water temperature has been 31°C (89°F), with a mean temperature of 18.5°C (65°F). With C-Reactor discharge, the flow in Fourmile Branch measured about 11.3 cubic meters (400 cubic feet) per second. The average flow at SRS Road A-12.2 (southwest of SC Highway 125) in water year 1991 was 1.8 cubic meters (63 cubic feet) per second (Wike et al. 1994). In its lower reaches, Fourmile Branch broadens and flows via braided channels through a delta formed by the deposition of sediments eroded from upstream during high flows. Downstream of the delta, the channels rejoin into one main channel. Most of the flow discharges into the Savannah River at river kilometer 245 (river mile 152.1), while a small portion of the creek flows west and enters Beaver Dam Creek. When the Savannah River floods, water from Fourmile Branch flows along the northern boundary of the floodplain swamp and joins with Pen Branch and Steel Creek, exiting the swamp via Steel Creek instead of flowing directly into the river.

Pen Branch and Indian Grave Branch drain an area of about 55 square kilometers (21 square miles). Pen Branch is approximately 24 kilometers (15 miles) long and follows a southwesterly path from its headwaters about 3.2 kilometers (2 miles) east of K-Area to the Savannah River Swamp. At the swamp, it flows parallel to the Savannah River for about 8 kilometers (5 miles) before it enters and mixes with the waters of Steel Creek. In its headwaters, Pen Branch is a largely undisturbed blackwater stream. Until K-Reactor shut down in 1988, Indian Grave Branch, a tributary of Pen Branch, received the thermal effluent from the reactor. When K-Reactor operated, Indian Grave Branch's average natural flow of 0.3 cubic meters (10 cubic feet) per second increased to about 11.3 cubic meters (400 cubic feet) per second. As required by a Record of Decision (DOE 1988), a recirculating cooling tower was completed in 1992 to cool water for K-Reactor. This system has not operated because K-Reactor was placed in cold standby in 1992. However, if it were to operate, the flow in Indian Grave Branch would be reduced to 1.6 cubic meters (55 cubic feet) per second with 1.3 cubic meters (45 cubic feet) per second coming from cooling tower blowdown (DOE 1987). This change would alter the water quality and temperature and flow regimes in Pen Branch. Currently, the Pen Branch system receives non-thermal effluents (e.g., non-process cooling water, ash basin effluent waters, powerhouse wastewater, and sanitary wastewater) from K-Area and sanitary effluent from the Central Shops (N-) Area. In water year 1991, the mean flow of Pen Branch at SRS Road A (SC 125) was 4.1 cubic meters (145 cubic feet) per second. During reactor operation, the mean water

temperatures of Pen Branch ranged from 33.5 to 48°C (92 to 119°F). Since the shutdown of K-Reactor, the mean temperature of Pen Branch has been 22°C (72°F) (Wike et al. 1994).

The headwaters of Steel Creek originate near P-Reactor. The creek flows southwesterly about 3 kilometers (approximately 2 miles) before it enters the headwaters of L-Lake. The lake is 6.5 kilometers (4 miles) long and relatively narrow, with an area of about 4.2 square kilometers (1,034 acres). Flow from the outfall of L-Lake travels about 5 kilometers (3 miles) before entering the Savannah River swamp and then another 3 kilometers (approximately 2 miles) before entering the Savannah River. Meyers Branch, the main tributary of Steel Creek, flows approximately 10 kilometers (6.2 miles) before entering Steel Creek downstream of the L-Lake dam and upstream of SRS Road A. The total area drained by the Steel Creek-Meyers Branch system is about 91 square kilometers (35 square miles). In 1954 (before the construction of L-Lake or Par Pond), Steel Creek started to receive effluents from L- and P-Reactors. By 1961, a total of 24 cubic meters (850 cubic feet) per second of thermal effluents was being released to Steel Creek. From 1961 to 1964 P-Reactor partially used the Par Pond recirculating system. In 1964, all P-Reactor effluent was diverted to Par Pond, and in 1968 L-Reactor was put on standby. In 1981, DOE initiated activities to restart L-Reactor. L-Lake was constructed in 1985 along the upper reaches of Steel Creek to cool the heated effluent from L-Reactor, and it received these effluents for several years until L-Reactor was shut down in 1988. In addition to receiving the cooling water from L-Reactor, Steel Creek also received ash basins runoff, nonprocess cooling water, powerhouse wastewater, reactor process effluents, sanitary treatment plant effluents, and vehicle wash waters. From October 1990 to September 1991, the mean flow rate of Steel Creek at SRS Road A was 4.7 cubic meters (185 cubic feet) per second, with an average temperature of 19°C (66°F) (Wike et al. 1994).

Lower Three Runs is a large blackwater creek draining about 460 square kilometers (286 square miles), with a 10-square kilometer (2,500-acre) impoundment, Par Pond, on its upper reaches. From the Par Pond dam, Lower Three Runs flows about 39 kilometers (24 miles) before entering the Savannah River. The SRS property includes Lower Three Runs and its floodplain from Par Pond to the river. The mean flow rate of Lower Three Runs in water year 1991 at Patterson Mill [8 kilometers (5 miles) below Par Pond] was 1.8 cubic meters (65 cubic feet) per second. The mean temperature at the Patterson Mill location during the period 1987 to 1991 was 18°C (64°F) (Wike et al. 1994).

Tables E.1-3 through E.1-7 present maximum and minimum values for water quality parameters for each of the remaining five major SRS tributaries that discharge to the Savannah River for 1993 (1992 for Beaver Dam Creek). The analytical results indicate that the water quality of SRS streams is generally acceptable, with the exception of the tritium concentrations. SCDHEC regulates the physical properties and concentrations of chemicals and metals in SRS effluents under the National Pollutant Discharge Elimination System program. SCDHEC also regulates chemical and biological water quality standards for SRS waters.

**Table 3-2. Water quality in the Savannah River upstream and downstream from SRS (calendar year 1993).a,b**

Parameter	Unit of measure <sup>c</sup>	MCL <sup>d,e</sup> or DCG <sup>f</sup>	Upstream		Downstream	
			Minimum <sup>g</sup>	Maximum <sup>g</sup>	Minimum	Maximum
Aluminum	mg/L	0.05-0.2 <sup>h</sup>	0.174	0.946	0.182	0.838
Ammonia	mg/L	NA <sup>i,j</sup>	0.04	0.13	0.02	0.11
Cadmium	mg/L	0.005 <sup>d</sup>	ND <sup>k</sup>	ND	ND	ND
Calcium	mg/L	NA	3.1	4.24	3.25	5.09
Chemical oxygen demand	mg/L	NA	ND	ND	ND	ND
Chloride	mg/L	250 <sup>h</sup>	4	13	4	12
Chromium	mg/L	0.1 <sup>d</sup>	ND	ND	ND	ND
Copper	mg/L	1.3 <sup>l</sup>	ND	ND	ND	ND
Dissolved oxygen	mg/L	>5.0 <sup>m</sup>	8.0	11.5	6.2	10.5
Fecal coliform	Colonies per 100 ml	1,000 <sup>m</sup>	13	1,960	5	854
Gross alpha radioactivity	pCi/L	15 <sup>d</sup>	<DL <sup>n</sup>	0.586	<DL	0.325
Iron	mg/L	0.3 <sup>h</sup>	0.41	1.39	0.516	1.15
Lead	mg/L	0.015 <sup>l</sup>	ND	0.002	ND	0.003
Magnesium	mg/L	NA	1.08	1.38	1.11	1.34
Manganese	mg/L	0.05 <sup>h</sup>	0.067	0.088	0.04	0.064
Mercury	mg/L	0.002 <sup>d,e</sup>	ND	ND	ND	ND
Nickel	mg/L	0.1 <sup>d</sup>	ND	ND	ND	ND
Nitrite/Nitrate (as nitrogen)	mg/L	10 <sup>d</sup>	0.17	0.31	0.18	0.31
Nonvolatile (dissolved) beta radioactivity	pCi/L	50 <sup>d</sup>	0.393	3.17	0.959	3.12
pH	pH units	6.5-8.5 <sup>h</sup>	6.0	6.8	6.0	6.7
Phosphate	mg/L	NA	ND	ND	ND	ND

Plutonium-238	pCi/L	1.6 <sup>f</sup>	<DL	0.00086	<DL	0.00174
Plutonium-239	pCi/L	1.2 <sup>f</sup>	<DL	0.000985	<DL	0.0012
Sodium	mg/L	NA	4.87	11.6	5.28	12.7
Strontium-90	pCi/L	8 <sup>f</sup>	<DL	0.174	0.009	0.22
Sulfate	mg/L	250 <sup>h</sup>	4.0	8.0	4.0	9.0
Suspended solids	mg/L	NA	5	17	5	16
Temperature	°C	32.2 <sup>o</sup>	9.0	24.8	9.1	25.7
Total dissolved solids	mg/L	500 <sup>h</sup>	48	75	49	90
Tritium	pCi/L	20,000 <sup>d,e</sup>	<DL	726	66	1,920
Zinc	mg/L	5 <sup>h</sup>	ND	ND	ND	0.012

a. Source: Arnett (1994).

b. Parameters are those DOE routinely measures as a regulatory requirement or as part of ongoing monitoring programs.

c. mg/L = milligrams per liter; a measure of concentration equivalent to the weight/volume ratio.

pCi/L = picocuries per liter; a picocurie is a unit of radioactivity; one trillionth of a curie.

d. Maximum Contaminant Level (MCL), EPA National Primary Drinking Water Standards (40 CFR Part 141). See glossary.

e. Maximum Contaminant Level (MCL): SCDHEC (1976a). See glossary.

f. DOE Derived Concentration Guides (DCGs) for water (DOE Order 5400.5, "Radiation Protection for the Public and the Environment"). DCG values are based on committed effective dose of 100 millirem per year for consistency with drinking water MCL of 4 millirem per year. See glossary.

g. Minimum concentrations of samples. The maximum listed concentration is the highest single result found during one sampling event.

h. Secondary Maximum Contaminant Level (SMCL). EPA National Secondary Drinking Water Regulations (40 CFR Part 143).

i. NA = none applicable.

j. Dependent upon pH and temperature.

k. ND = none detected.

l. Action level for lead and copper.

m. WQS = water quality standard. See glossary.

n. Less than (<) indicates concentration below analyses detection limit (DL).

o. Shall not exceed weekly average of 32.2°C (90°F) after mixing nor rise more than 2.8°C (5°F) in 1 week unless appropriate temperature criterion mixing zone has been established.

**Table 3-3. Water quality in Upper Three Runs downstream from SRS discharges (calendar year 1993).a,b**

Parameter	Unit of measurec	MCLd,e or DCGf	Minimumg	Maximumg
Aluminum	mg/L	0.05-0.2 <sup>h</sup>	0.018	0.261
Ammonia	mg/L	NA <sup>ij</sup>	ND <sup>k</sup>	0.04
Cadmium	mg/L	0.005 <sup>d</sup>	ND	ND
Calcium	mg/L	NA	ND	ND
Chemical oxygen demand	mg/L	NA	ND	ND
Chloride	mg/L	250 <sup>h</sup>	2	3
Chromium	mg/L	0.1 <sup>d</sup>	ND	ND
Copper	mg/L	1.3 <sup>l</sup>	ND	ND
Dissolved oxygen	mg/L	>5 <sup>m</sup>	5.0	12.5
Fecal coliform	Colonies per 100 ml	1,000 <sup>m</sup>	52	1,495
Gross alpha radioactivity	pCi/L	15 <sup>d</sup>	<DL <sup>n</sup>	3.57
Iron	mg/L	0.3 <sup>h</sup>	0.363	0.709
Lead	mg/L	0.015 <sup>l</sup>	ND	0.002
Magnesium	mg/L	NA	0.034	0.356
Manganese	mg/L	0.05 <sup>h</sup>	0.012	0.034
Mercury	mg/L	0.002 <sup>d,e</sup>	ND	ND
Nickel	mg/L	0.1 <sup>d</sup>	ND	ND
Nitrite/Nitrate (as nitrogen)	mg/L	10 <sup>d</sup>	0.10	0.19
Nonvolatile (dissolved) beta radioactivity	pCi/L	50 <sup>d</sup>	0.205	3.94
pH	pH units	6.5-8.5 <sup>h</sup>	5.2	8.0
Phosphate	mg/L	NA	ND	ND
Sodium	mg/L	NA	1.44	2.01
Strontium-89/90	pCi/L	-	<DL	0.783
Sulfate	mg/L	250 <sup>h</sup>	1	3
Suspended solids	mg/L	NA	1	20

Temperature	°C	32.2 <sup>o</sup>	9.7	24.4
Total dissolved solids	mg/L	500 <sup>h</sup>	19	47
Tritium	pCi/L	20,000 <sup>d,e</sup>	<DL	17,900
Zinc	mg/L	5 <sup>h</sup>	ND	ND

a. Source: Arnett (1994).

b.Parameters are those DOE routinely measures as a regulatory requirement or as a part of ongoing monitoring programs.

c.mg/L = milligrams per liter; a measure of concentration equivalent to the weight/volume ratio.

pCi/L = picocuries per liter; a picocurie is a unit of radioactivity; a trillionth of a curie.

d.Maximum Contaminant Level (MCL), EPA National Primary Drinking Water Standards (40 CFR Part 141). See glossary.

e.Maximum Contaminant Level; SCDHEC (1976a). See glossary.

f.DOE Derived Concentration Guides (DCGs) for water (DOE Order 5400.5). DCG values are based on committed effective doses of 4 millirem per year for consistency with drinking water MCL of 4 millirem per year. See glossary.

g.Minimum concentrations of samples taken at the downstream monitoring station. The maximum listed concentration is the highest single result during one sampling event.

h.Secondary Maximum Contaminant Level (SMCL), EPA National Secondary Drinking Water Regulations (40 CFR Part 143).

i.NA = none applicable.

j.Depends on pH and temperature.

k.ND = none detected.

l.Action level for lead and copper.

m.WQS = water quality standard. See glossary.

n.Less than (<) indicates concentration below analysis detection limit (DL).

o.Shall not exceed weekly average of 32.2°C (90°F) after mixing nor rise more than 2.8°C (5°F) in 1 week unless appropriate temperature criterion mixing zone has been established.

## 3.5 Air Resources

### 3.5.1 CLIMATE AND METEOROLOGY

The climate at SRS is temperate, with short, mild winters and long, humid summers. Throughout the year, the weather is affected by warm, moist maritime air masses (DOE 1991).

Summer weather usually lasts from May through September, when the area is strongly influenced by the western extension of the semi-permanent Atlantic subtropical "Bermuda" high pressure system. Winds are relatively light, and migratory low pressure systems and fronts usually remain well to the north of the area. The Bermuda high is a relatively persistent feature, resulting in few breaks in the summer heat. Climatological records for the Augusta, Georgia, area indicate that during the summer

months, high temperatures were greater than 32.2°C (90°F) on more than half of all days. The relatively hot and humid conditions often result in scattered afternoon and evening thunderstorms (Hunter 1990).

The influence of the Bermuda high begins to diminish during the fall, resulting in relatively dry weather and moderate temperatures. Fall days are frequently characterized by cool, clear mornings and warm, sunny afternoons (Hunter 1990).

During the winter, low pressure systems and associated fronts frequently affect the weather of the SRS area. Conditions often alternate between warm, moist subtropical air from the Gulf of Mexico region and cool, dry polar air. The Appalachian Mountains to the north and northwest of SRS moderate the extremely cold temperatures associated with occasional outbreaks of arctic air. Consequently, less than one-third of all winter days have minimum temperatures below freezing, and temperatures below -7°C (20°F) occur infrequently. Snow and sleet occur on average less than once per year (Hunter 1990).

Outbreaks of severe thunderstorms and tornadoes occur more frequently during the spring than during the other seasons. Although spring weather is variable and relatively windy, temperatures are usually mild (Hunter 1990).

Data on severe weather conditions are important considerations in the selection of design criteria for buildings and structures at SRS. Information on the frequency and severity of past incidents provides a basis for predicting the probabilities and consequences of releases of airborne pollutants.

#### **3.5.1.1 Occurrence of Violent Weather**

The SRS area experiences an average of 55 thunderstorms per year, half of which occur during the summer months of June, July, and August (Shedrow 1993). On average, lightning flashes will strike six times per year on a square kilometer (0.39 square mile) of ground (Hunter 1990). Thunderstorms can generate wind speeds as high as 64 kilometers (40 miles) per hour and even stronger gusts. The highest 1-minute wind speed recorded at Bush Field in Augusta, Georgia, between 1950 and 1990 was 100 kilometers (62 miles) per hour (NOAA 1990).

Since SRS operations began, nine confirmed tornadoes have occurred on or close to SRS. Eight caused light to moderate damage. The tornado of October 1, 1989, caused considerable damage to timber resources on about 4.4 square kilometers (1,097 acres) and lighter damage on about 6 square kilometers (1,497 acres) over southern and eastern areas of the site. Winds produced by this tornado were estimated to have been as high as 240 kilometers per hour (150 miles per hour) (Parker and Kurzeja 1990). No tornado-related damage has occurred to SRS production facilities.

Based on tornado statistics for the SRS area, the average frequency of a tornado striking any given location in South Carolina was estimated to be  $7.11 \times 10^{-5}$  per year. This means that a tornado could strike any given location about once every 14,000 years (Bauer et al. 1989).

The nuclear materials processing facilities at SRS were built to withstand a maximum tornado wind speed of 451 kilometers per hour (280 miles per hour) (Bauer et al. 1989). The estimated probability of any location on SRS experiencing wind speeds equal to or greater than this is  $1.2 \times 10^{-7}$  per year.

Such a tornado would occur about once every 10 million years (Bauer et al. 1989).

A total of 36 hurricanes have caused damage in South Carolina between 1700 and 1989. The average frequency of occurrence of a hurricane in the state is once every 8 years; however, the observed interval between hurricanes has ranged from as short as 2 months to as long as 27 years. Eighty percent of hurricanes have occurred in August and September.

Winds produced by Hurricane Gracie, which passed to the north of SRS on September 29, 1959, were as high as 121 kilometers (75 miles) per hour in F-Area. No other hurricane-force wind has been measured on SRS. Heavy rainfall and tornadoes, which frequently accompany tropical weather systems, usually have the greatest hurricane-related impact on SRS operations (Bauer et al. 1989).

#### **3.5.1.2 Wind Speed and Direction**

A joint frequency summary (wind rose) of hourly averaged wind speeds and directions collected from the H- Area meteorological tower at a height of 61 meters (200 feet) during the 5-year period 1987 through 1991 is shown in Figure 3-8. This figure indicates that the prevailing wind directions are from the south, southwest, west, and northeast. Winds from the south, southwest, and west directions occurred during about 35 percent of the monitoring period (Shedrow 1993).

The average wind speed for the 5-year period was 13.7 kilometers (8.5 miles) per hour. Hourly averaged wind speeds less than 7.2 kilometers (4.5 miles) per hour occurred about 10 percent of the time. Seasonally averaged wind speeds were highest during the winter [14.8 kilometers (9.2 miles) per hour] and lowest during the summer [12.2 kilometers (7.6 miles) per hour] (Shedrow 1993).

#### **3.5.1.3 Atmospheric Stability**

Air dispersion models that predict downwind ground-level concentrations of an air pollutant released from a source are based on specific parameters such as stack height, wind speed, pollutant emission rate, and air dispersion coefficients. The air dispersion coefficients used in modeling are determined by atmospheric stability.

#### **Figure 3-8. Wind rose for SRS, 1987 through 1991.**

The ability of the atmosphere to disperse air pollutants is frequently expressed in terms of the seven Pasquill-Gifford atmospheric turbulence (stability) classes A through G. Occurrence frequencies for each of the stability classes at SRS have been determined using turbulence data collected from the SRS meteorological towers during the 5-year period 1987 through 1991. Relatively turbulent atmospheric conditions that increase atmospheric dispersion, represented by the unstable classes A, B, and C, occurred approximately 56 percent of the time. Stability class D, which represents conditions that are moderately favorable for atmospheric dispersion, occurred approximately 23 percent of the time. Relatively stable conditions that minimize atmospheric dispersion, represented by classes E, F, and G, occurred about 21 percent of the time (Shedrow 1993).

In the southeastern United States, high air pollution levels typically occur when the air is stagnant and

there is little dispersion of pollutants. Stagnant episodes generally occur when atmospheric pressure is high (i.e., the area is under a high-pressure system). Under a stagnating high-pressure system, the maximum height of air mixing is less than 1,524 meters (5,000 feet), and the average wind speed is less than 4.0 meters per second (9 miles per hour). According to upper air data, episodes of poor dispersion in the vicinity of SRS lasted for at least 2 days on 12 occasions over a 5-year period (1960 through 1964). Episodes lasting at least 5 days occurred on two occasions. A stagnation episode is defined as limited dispersion lasting 4 or more days. Two stagnation episodes have occurred in the SRS area each year over the 40-year period from 1936 through 1975. The total number of stagnant days averaged about 10 per year (Bauer et al. 1989).

### 3.5.2 EXISTING RADIOLOGICAL CONDITIONS

#### 3.5.2.1 Background and Baseline Radiological Conditions

Ambient air concentrations of radionuclides at SRS include nuclides of natural origins, such as radon from uranium in soils; man-made radionuclides, such as fallout from testing of nuclear weapons; and emissions from coal-fired and nuclear power plants. SRS operates a 35-station atmospheric surveillance program. Stations are located inside the SRS perimeter, on the SRS perimeter, and at distances up to 161 kilometers (100 miles) from SRS (Arnett, Karapatakis, and Mamatey 1994).

Routine SRS operations release quantities of alpha- and beta-gamma-emitting radioactive materials in the form of gases and particulates. Gross alpha and nonvolatile beta measurements are used as a screening method for determining the concentration of all radionuclides in the air.

The average 1990 to 1993 gross alpha radioactivity and nonvolatile beta radioactivity measured at SRS and at distances of 40 kilometers (25 miles) to 161 kilometers (100 miles) from SRS are shown in Table 3-4. The maximum levels of onsite gross alpha and gross beta radioactivity were found near production/processing areas. For each year, average onsite gross alpha and nonvolatile beta radioactivity concentrations were similar to the average concentrations measured in offsite air (Arnett, Karapatakis, and Mamatey 1994). Nonvolatile beta concentrations do not include tritium (which accounts for more than 99 percent of the airborne radioactivity released from SRS) or carbon-14.

Tritium levels in 1993 are not directly comparable to those observed in previous years because the sampling protocol for atmospheric tritium oxide was changed in 1993. For 1993, the highest annual average concentration of tritium in air over SRS was  $1.06 \times 10^{-9}$  microcuries per milliliter. The maximum offsite tritium concentration was slightly higher than the 1992 level of  $5.3 \times 10^{-11}$  microcuries per milliliter (Arnett, Karapatakis, and Mamatey 1994).

**Table 3-4. Average concentrations of gross alpha and nonvolatile beta radioactivity measured in air (1991 to 1993) (microcuries per milliliter of air).a**

Location	Number of Locations	Average gross alpha radioactivity			Average nonvolatile beta radioactivity		
		1991	1992	1993	1991	1992	1993
Onsite	5	$2.5 \times 10^{-15}$	$1.8 \times 10^{-15}$	$1.9 \times 10^{-15}$	$1.8 \times 10^{-14}$	$1.9 \times 10^{-14}$	$1.8 \times 10^{-14}$
SRS perimeter	14	$2.6 \times 10^{-15}$	$1.8 \times 10^{-15}$	$1.8 \times 10^{-15}$	$1.8 \times 10^{-14}$	$1.9 \times 10^{-14}$	$1.9 \times 10^{-14}$
40-kmb radius	12	$2.5 \times 10^{-15}$	$1.7 \times 10^{-15}$	$1.8 \times 10^{-15}$	$1.8 \times 10^{-14}$	$1.8 \times 10^{-14}$	$1.8 \times 10^{-14}$
161-km radius	4	$2.6 \times 10^{-15}$	$1.7 \times 10^{-15}$	$2.0 \times 10^{-15}$	$1.8 \times 10^{-14}$	$1.7 \times 10^{-14}$	$2.0 \times 10^{-14}$

a. Source: Arnett, Karapatakis, and Mamatey (1994).

b. Kilometer; to convert to miles, multiply by 0.621.

### 3.5.2.2 Sources of Radiological Emissions

The major SRS production facilities and the types and quantities of radionuclides released during 1993 are presented in Table 3-5. The dose to a member of the public from these releases, calculated by the MAXIGASP computer model, was 0.11 millirem. This dose is 1.1 percent of the 10-millirem-per-year EPA limit (see 40 CFR 52.21). Tritium (H-3), in both elemental and oxide forms, constitutes more than 99 percent of the radioactivity released to the atmosphere from SRS operations (Arnett, Karapatakis, and Mamatey 1994).

**Table 3-5. Atmospheric releases by source facility in 1993.a**

Radionuclide <sup>b</sup>	Half-life	Curies <sup>c</sup>						Total
		Reactors	Separations	Reactor materials	Heavy water	SRTCd	Diffuse and fugitive	
<b>Gases and Vapors</b>								
H-3 (oxide)	12.3 yrs	3.85x10 <sup>4</sup>	9.39x10 <sup>4</sup>	NR <sup>f</sup>	448	NR	43.1	1.33x10 <sup>5</sup>
H-3 (elem.)	12.3 yrs	NR	5.82x10 <sup>4</sup>	NR	NR	NR	NR	5.82x10 <sup>4</sup>
H-3 Total	12.3 yrs	3.85x10 <sup>4</sup>	1.52x10 <sup>5</sup>	NR	448	NR	43.1	1.91x10 <sup>5</sup>
Carbon-14	5.7x10 <sup>3</sup> yrs	NR	0.0169	NR	NR	NR	4.00x10 <sup>-6</sup>	0.0169

Iodine-129	1.6x10 <sup>7</sup> yrs	NR	0.00496	NR	NR	NR	6.88x10 <sup>-7</sup>	0.00496
Iodine-131	8 days	NR	8.89x10 <sup>-5</sup>	NR	NR	5.92x10 <sup>-5</sup>	NR	1.48x10 <sup>-4</sup>
Iodine-133	20.8 hrs	NR	NR	NR	NR	0.00196	NR	0.00196
Xenon-135	9.1 hrs	NR	NR	NR	NR	0.0319	NR	0.0319
Particulates								
S-35	87.2 days	NR	NR	NR	NR	NR	2.00x10 <sup>-6</sup>	2.00x10 <sup>-6</sup>
Cobalt-60	5.3 yrs	NR	5.89x10 <sup>-9</sup>	NR	NR	NR	3.34x10 <sup>-17</sup>	5.89x10 <sup>-9</sup>
Ni-63	100 yrs	NR	NR	NR	NR	NR	2.00x10 <sup>-7</sup>	2.00x10 <sup>-7</sup>
Sr-89,90 <sup>g</sup>	29.1 yrs	1.81x10 <sup>-4</sup>	0.00188	8.32x10 <sup>-5</sup>	7.19x10 <sup>-5</sup>	1.19x10 <sup>-5</sup>	1.11x10 <sup>-4</sup>	0.00227
Zr-95 (Nb-95)	64 days	NR	NR	NR	NR	NR	2.39x10 <sup>-14</sup>	2.39x10 <sup>-14</sup>
Ru-106	1.0 yrs	3.99x10 <sup>-6</sup>	5.76x10 <sup>-9</sup>	NR	NR	NR	4.96x10 <sup>-12</sup>	4.00x10 <sup>-6</sup>
Sb-125	2.8 yrs	NR	NR	NR	NR	NR	7.27x10 <sup>-15</sup>	7.27x10 <sup>-15</sup>
Cesium-134	2.1 yrs	NR	1.49x10 <sup>-6</sup>	NR	NR	NR	1.40x10 <sup>-17</sup>	1.49x10 <sup>-6</sup>
Cesium-137	30.2 yrs	1.04x10 <sup>-4</sup>	5.28x10 <sup>-4</sup>	NR	NR	1.51x10 <sup>-6</sup>	4.33x10 <sup>-11</sup>	6.34x10 <sup>-4</sup>
Cesium-144	285 days	NR	NR	NR	NR	NR	1.13x10 <sup>-13</sup>	1.13x10 <sup>-13</sup>
Eu-154	8.6 yrs	NR	NR	NR	NR	NR	3.44x10 <sup>-13</sup>	3.44x10 <sup>-13</sup>
Eu-155	4.7 yrs	NR	NR	NR	NR	NR	1.63x10 <sup>-13</sup>	1.63x10 <sup>-13</sup>
U-235,238	4.5x10 <sup>9</sup> yrs	NR	0.00186	1.55x10 <sup>-5</sup>	NR	2.89x10 <sup>-8</sup>	4.74x10 <sup>-5</sup>	0.00192

Pu-238	87.7 yrs	NR	0.00121	NR	NR	$1.00 \times 10^{-8}$	$4.63 \times 10^{-12}$	0.00121
Pu-239 <sup>h</sup>	$2.4 \times 10^4$ yrs	$4.11 \times 10^{-6}$	0.00106	$3.50 \times 10^{-6}$	$8.42 \times 10^{-7}$	$9.41 \times 10^{-6}$	$4.70 \times 10^{-7}$	0.00108
Am-241,243	$7.4 \times 10^3$ yrs	NR	$1.42 \times 10^{-4}$	NR	NR	$1.34 \times 10^{-6}$	$8.86 \times 10^{-13}$	$1.43 \times 10^{-4}$
Cm-242,244	18.1 yrs	NR	$4.96 \times 10^{-5}$	NR	NR	$6.83 \times 10^{-6}$	$7.33 \times 10^{-12}$	$5.64 \times 10^{-5}$

a. Source: Arnett, Karapatakis, and Mamatey (1994).

b. H-3= tritium	Sb = antimony
S = sulfur	Eu = europium
Ni= nickel	U = uranium
Sr= strontium	Pu = plutonium
Zr= zirconium	Am = americium
Nb= niobium	Cm = curium
Ru= rubidium	

c. One curie equals  $3.7 \times 10^{10}$  becquerels.

d. Savannah River Technology Center.

e. Estimated releases from minor unmonitored diffuse and fugitive sources (i.e., sources other than stacks or vents such as windows and doors).

f. NR = not reported.

g. Includes unidentified beta-gamma emissions.

h. Includes unidentified alpha emissions.

### 3.5.3 NONRADIOLOGICAL CONDITIONS

#### 3.5.3.1 Background Air Quality

SRS is in an area that is designated an attainment area because it complies with National Ambient Air Quality Standards for criteria pollutants, including sulfur dioxide, nitrogen oxides (reported as nitrogen dioxide), particulate matter (less than or equal to 10 microns in diameter), carbon monoxide, ozone, and lead (see 40 CFR 81). The closest nonattainment area (an area that does not meet National Ambient Air Quality Standards) to SRS is the Atlanta, Georgia, air quality region, which is 233

kilometers (145 miles) to the west.

Sources in attainment areas must comply with Prevention of Significant Deterioration regulations. The regulations apply to new and modified sources of air pollution if the net increase in emissions from the new or modified source is determined to exceed the Prevention of Significant Deterioration annual threshold limit (see 40 CFR 52.21). Development at SRS has not triggered Prevention of Significant Deterioration permitting requirements, nor is it expected to trigger such requirements in the future.

#### **3.5.3.2 Air Pollutant Source Emissions**

DOE has demonstrated compliance with state and Federal air quality standards by modeling ambient air concentrations that would result from maximum potential emission rates using the calendar year 1990 (most recent available) air emissions inventory data as the baseline year. The compliance demonstration also included sources forecast for construction or operation through 1995 and permitted sources supporting the Defense Waste Processing Facility (WSRC 1993b). SRS based its calculated emission rates for the compliance demonstration sources on process knowledge, source testing, permitted operating capacity, material balance, and EPA air pollution emission factors (EPA 1985).

#### **3.5.3.3 Ambient Air Monitoring**

At present, SRS does not perform onsite ambient air quality monitoring. State agencies operate ambient air quality monitoring sites in Barnwell and Aiken Counties in South Carolina, and Richmond County in Georgia. These counties, which are near SRS, are in compliance with National Ambient Air Quality Standards for particulate matter, lead, ozone, sulfur dioxide, nitrogen oxides, and carbon monoxide (see 40 CFR 50).

#### **3.5.3.4 Atmospheric Dispersion Modeling**

SRS has modeled atmospheric dispersion of both maximum potential and actual emissions of criteria and toxic air pollutants using EPA's Industrial Source Complex Short Term Model (EPA 1992). This modeling was performed using the most recent (1991) quality-assured onsite meteorological data. The maximum potential emissions data included sources of air pollution at SRS that either existed or were permitted to operate as of December 1992. Emissions data for 1990 were used for the modeling of actual emissions (WSRC 1993b; Hunter and Stewart 1994). The results of this modeling are summarized in Tables 3-6 and 3-7, which list the maximum concentrations occurring at or beyond the SRS boundary. Actual SRS boundary concentrations are probably lower than values reported in these tables.

#### **3.5.3.5 Summary of Nonradiological Air Quality**

SCDHEC has air quality regulatory authority over SRS and determines compliance based on pollutant emission rates and estimates of ambient concentrations at the SRS perimeter based on modeling. SRS complies with National Ambient Air Quality Standards and the gaseous fluoride and total suspended particulate standards, as required by SCDHEC Regulation R.61-62.5, Standard 2 ("Ambient Air Quality Standards"). These standards are shown in Table 3-6. SRS complies with SCDHEC Regulation R.61-62.5, Standard 8 ("Toxic Air Pollutants"), which regulates the emission of 257 toxic air pollutants (EPA 1992). SRS has identified emission sources for 139 of the 257 regulated air toxics; the modeling results indicate that SRS complies with SCDHEC air quality standards. Table 3-7 lists concentrations of air toxics at the SRS boundary which exceed 1 percent of SCDHEC standards. Concentrations of all other air toxics are less than 1 percent of SCDHEC standards and are shown in Table E.2-1 in Appendix E.

### 3.6 Ecological Resources

The United States acquired the SRS property in 1951. At that time, the site was approximately 60 percent forest and 40 percent cropland and pasture (Wike et al. 1994). At present, more than 90 percent of SRS is forested. An extensive forest management program conducted by the Savannah River Forest Station, which is operated by the U.S. Forest Service under an interagency agreement with DOE, has converted many former pastures and fields to pine plantations. Except for SRS production and support areas, natural succession has reclaimed many previously disturbed areas.

SRS land management practices have maintained the biodiversity in the region. Satellite imagery reveals that SRS is a circle of wooded habitat surrounded by a matrix of cleared uplands and narrow forested wetland corridors. SRS provides more than 730 square kilometers (280 square miles) of contiguous forest that supports plant communities in various stages of succession. Carolina bay depressional wetlands, the Savannah River swamp, and several relatively intact longleaf pine-wiregrass (*Pinus palustris-Aristida stricta*) communities contribute to the biodiversity of SRS and the region. Table 3-8 lists land cover in undeveloped areas of SRS.

The land used for production and support facilities is heavily industrialized and has little natural vegetation inside the fenced areas. These areas consist of buildings, paved parking lots, graveled construction areas, and laydown yards. While there is some landscaping around the buildings and some vegetation along the surrounding drainage ditches, most of these areas have little or no vegetation. Wildlife species common to the vegetated habitat surrounding the facilities often frequent the developed areas.

Most new development needed to support waste management would be within previously disturbed areas and would occur on existing graveled or paved areas. Undeveloped land required for expanded waste management facilities is located in E-Area near the center of SRS and approximately 1.6 kilometers (1 mile) southeast of Upper Three Runs (Figure 3-2).

Figure 3-9 shows the existing land cover of the area where most new waste management facilities would be located. The undeveloped land is comprised of 0.2 square kilometer (49 acres) of longleaf pine planted in 1988; 0.4 square kilometer (99 acres) of slash pine (*P. elliotti*) planted in 1959; 0.36 square kilometer (88 acres) of loblolly pine planted in 1946; 0.73 square kilometer (180 acres) of white oak (*Quercus alba*), red oak (*Q. rubra*), and hickory (*Carya sp.*) regenerated in 1922; 0.64 square kilometer (158 acres) of longleaf pine regenerated in 1922, 1931, or 1936; 0.32 square

kilometer (79 acres) of loblolly pine planted in 1987; and 0.12 square kilometer (30 acres) of recently harvested mixed pine hardwood (see Figure 3-9).

**Table 3-6. Estimated ambient concentration contributions of criteria air pollutants from existing SRS sources and sources planned for construction or operation through 1995 (micrograms per cubic meter of air).a,b**

Pollutant <sup>c</sup>	Averaging time	SRS maximum potential concentration (mg/m <sup>3</sup> )	Concentrations based on actual emissions (mg/m <sup>3</sup> )	Most stringent AAQS <sup>d</sup> (Federal or state) (mg/m <sup>3</sup> )	Maximum potential concentration as a percent of AAQSe
SO <sub>2</sub>	3 hours	1,514 (1,245) <sup>f</sup>	823	1,300 <sup>g,h</sup>	96
	24 hours	449 (300)	196	365 <sup>g,h</sup>	82
	Annual	22.9	14.5	80 <sup>g</sup>	29
NO <sub>x</sub>	Annual	14.8	5.7	100 <sup>g</sup>	15
CO	1 hour	434	171	40,000 <sup>g</sup>	1
	8 hours	57.8	22	10,000 <sup>g</sup>	0.6
Gaseous fluorides (as HF)	12 hours	2.22	1.99	3.7 <sup>e</sup>	60
	24 hours	1.16	1.04	2.9 <sup>e</sup>	40
	1 week	0.44	0.39	1.6 <sup>e</sup>	28
	1 month	0.11	0.09	0.8 <sup>e</sup>	14
PM <sub>10</sub>	24 hours	80.4	50.6	150 <sup>g</sup>	54
	Annual	5.2	2.9	50 <sup>g</sup>	10
O <sub>3</sub>	1 hour	NA <sup>i</sup>	NA	235 <sup>g</sup>	NA
TSP	Annual geometric mean	16.1	12.6	75 <sup>e</sup>	21
Lead	Calendar quarter mean	0.001	0.0004	1.5 <sup>e</sup>	0.07

a. Source: Stewart (1994).

b. The concentrations are the maximum values at the SRS boundary.

c. SO<sub>2</sub> = sulfur dioxide; NO<sub>x</sub> = nitrogen oxides; CO = carbon monoxide; HF = hydrogen fluoride; PM<sub>10</sub> = particulate matter < 10 microns in diameter; O<sub>3</sub> = ozone; TSP = total suspended particulates.

d. AAQS = Ambient Air Quality Standard.

e. Source: SCDHEC (1976b).

f. The value in parentheses is the second highest maximum potential value.

g. Source: 40 CFR Part 50.

h. Concentration not to be exceeded more than once a year.

i. NA = not available.

**Table 3-7. SRS modeling results for toxic air pollutants that exceed 1 percent of SCDHEC air quality standards (micrograms per cubic meter of air).a,b,c**

Pollutant	Maximum allowable concentration (mg/m <sup>3</sup> )	Concentration at SRS boundary (mg/m <sup>3</sup> )	Percent of standard <sup>d</sup>
Chlorine	75.00	7.63023	10.17
Formic Acid	225.00	2.41990	1.08
Nitric Acid	125.00	50.95952	40.77
Phosphoric Acid	25.00	0.46236	1.85
Acrolein	1.25	0.01585	1.27
Benzene	150.00	31.71134	21.14
Bis (chloromethyl) Ether	0.03	0.00180	6.00
Cadmium Oxide	0.25	0.02136	8.54
Chloroform	250.00	4.95658	1.98
Cobalt	0.25	0.20628	82.51
3,3-Dichlorobenzidine	0.15	0.00180	1.20
Manganese	25.00	0.82129	3.29
Mercury	0.25	0.01393	5.57
Nickel	0.50	0.27106	54.21
Parathion	0.50	0.00737	1.47

a. Source: WSRC (1993b).

b. Concentrations are based on maximum potential emissions.

c. See Table E.2-1 for a complete list of toxic pollutant results.

d. Percent of standard =  $\times 100$

**Table 3-8. Land cover of undeveloped areas of SRS.a**

Types of land cover	Square kilometers	Square miles	Percent of total
Longleaf pine	150	58	20
Loblolly pine	258	100	35
Slash pine	117	45	16
Mixed pine/hardwood	23	9	3
Upland hardwood	20	8	3
Bottomland hardwood	117	45	16
Savannah River swamp	49	19	7
Total <sup>b</sup>	734	284	100

a.Source: USDA (1991a).

b.Excludes production areas; total reflects undeveloped land only.

### 3.6.1 Terrestrial Ecology

SRS is near the transition between northern oak-hickory-pine forest and southern mixed forest. Thus, species typical of both associations are found on SRS (Dukes 1984). Farming, fire, soil, and topography have strongly influenced SRS vegetation patterns.

A variety of plant communities occurs in the upland areas (Dukes 1984). Typically, scrub oak communities are found on the drier, sandier areas. Longleaf pine, turkey oak (*Quercus laevis*), bluejack oak (*Q. incana*), and blackjack oak (*Q. marilandica*) dominate these communities, which typically have understories of wire grass and huckleberry (*Vaccinium* spp.). Oak-hickory communities are usually located on more fertile, dry uplands; characteristic species are white oak, post oak (*Q. stellata*), red oak, mockernut hickory (*Carya tomentosa*), pignut hickory (*C. glabra*), and loblolly pine, with an understory of sparkleberry (*Vaccinium arboreum*), holly (*Ilex* spp.), greenbriar (*Smilax* spp.), and poison ivy (*Toxicodendron radicans*) (Dukes 1984; Wike et al. 1994).

The departure of residents in 1951 and the subsequent reforestation have provided the wildlife of SRS with excellent habitat. Furbearers such as gray fox (*Urocyon cinereoargenteus*), opossum (*Didelphis virginiana*), and bobcat (*Felis rufus*) are relatively common throughout the site. Game species such as gray squirrel (*Sciurus carolinensis*), fox squirrel (*S. niger*), white-tailed deer (*Odocoileus virginianus*), eastern cottontail (*Sylvilagus floridanus*), mourning dove (*Zenaidura macroura*), northern bobwhite (*Colinus virginianus*), and eastern wild turkey (*Meleagris gallopavo*) are also common (Cothran et al. 1991; Wike et al. 1994). Waterfowl are common on most SRS wetlands, ponds, reservoirs, and in the Savannah River swamp and have been studied extensively (Mayer, Kennamer, and Hoppe 1986a; Wike et al. 1994). The reptiles and amphibian species of SRS include 17 salamanders, 26 frogs and toads, 1 crocodylian, 12 turtles, 9 lizards, and 36 snakes. Gibbons and Semlitsch (1991) provides an overview, description, and identification keys to the reptiles and amphibians of SRS.

Undeveloped land in E-Area contains suitable habitat for white-tailed deer and feral hogs (*Sus scrofa*), as well as other animal species common to the mixed pine/hardwood forests of South Carolina.

### 3.6.2 WETLANDS

SRS has extensive, widely distributed wetlands, most of which are associated with floodplains, creeks, or impoundments. In addition, approximately 200 Carolina bays occur on SRS (Shields et al. 1982; Schalles et al. 1989). Carolina bays are unique wetland features of the southeastern United States. They are isolated wetland habitats dispersed throughout the uplands of SRS. The more than 200 bays on SRS exhibit extremely variable hydrology and a range of plant communities from herbaceous marsh to forested wetland (Shields et al. 1982; Schalles et al. 1989).

The Savannah River bounds SRS to the southwest for approximately 32 kilometers (20 miles). The river floodplain supports an extensive swamp, covering about 49 square kilometers (19 square miles) of SRS; a natural levee separates the swamp from the river. Timber was cut in the swamp in the late 1800s. At present, the swamp forest consists of second-growth bald cypress (*Taxodium distichum*), black gum (*Nyssa sylvatica*), and other hardwood species (Sharitz, Irwin, and Christy 1974; USDA 1991a; Wike et al. 1994).

#### **Figure 3-9.**

Six streams drain SRS and eventually flow into the Savannah River. Each stream has floodplains with bottomland hardwood forests or scrub-shrub wetlands in varying stages of succession. Dominant species include red maple (*Acer rubrum*), box elder (*A. negundo*), bald cypress, water tupelo (*Nyssa aquatica*), sweetgum (*Liquidambar styraciflua*), and black willow (*Salix nigra*) (Workman and McLeod 1990).

Raccoon (*Procyon lotor*), beaver (*Castor canadensis*), and otter (*Lutra canadensis*) are relatively common throughout the wetlands of SRS. The Savannah River Ecology Laboratory has conducted extensive studies of reptile and amphibian use of the wetlands of SRS (Schalles et al. 1989).

Bottomland hardwood forest wetlands are located north of E-Area along Upper Three Runs. These wetlands, dominated by sweetgum and yellow poplar (*Liriodendron tulipifera*), are flooded during most winters.

### 3.6.3 Aquatic Ecology

The aquatic resources of SRS have been the subject of intensive study for more than 30 years. Research has focused on the flora and fauna of the Savannah River, the tributaries of the river that drain SRS, and the artificial impoundments on two of the tributary systems. Section 3.3.3 describes the water quality of those aquatic systems. In addition, several monographs (Patrick, Cairns, and Roback 1967; Dahlberg and Scott 1971; Bennett and McFarlane 1983), the eight-volume comprehensive cooling water study (du Pont 1987), and three eiss (DOE 1984, 1987, 1990) describe

the aquatic biota (fish and macroinvertebrates) and aquatic systems of SRS.

Based on studies by the Academy of Natural Sciences of Philadelphia and others (Floyd, Morse, and McArthur 1993), Upper Three Runs has one of the richest aquatic insect faunas of any stream in North America. At least 551 species of aquatic insects, including at least 52 species and 2 genera new to science, have been identified (Wike et al. 1994). A recent study identified 93 species of caddisflies, including three species that had not previously been found in South Carolina and two species that are new to science (Floyd, Morse, and McArthur 1993). Other insect species found in the creek are considered endemic, rare, or of limited distribution (Floyd, Morse, and McArthur 1993). Between 1987 and 1991, the density and variety of insects collected from Upper Three Runs decreased for unknown reasons. Data from 1991 indicate that the insect communities may be recovering from this disturbance (Wike et al. 1994).

The American sandburrowing mayfly (*Dolania americana*), a relatively common mayfly in Upper Three Runs, is listed by the Federal government as a candidate species for protection under the Endangered Species Act. The species is sensitive to siltation, organic loading, and toxic releases (Wike et al. 1994).

A recent study (Davis and Mulvey 1993) has identified an extremely rare clam species (*Elliptio hepatica*) in the Upper Three Runs drainage.

### 3.6.4 Threatened and Endangered Species

Several threatened, endangered, or candidate plant and animal species are known to occur on SRS. Table 3-9 lists those species (Wike et al. 1994). SRS contains no designated critical habitat for any listed threatened or endangered species.

The smooth coneflower (*Echinacea laevigata*) is the only endangered plant species found on SRS. One colony is located on Burma Road approximately 5 kilometers (3 miles) south of the waste management sites. A second colony is located near the junctions of SRS Roads 9 and B (LeMaster 1994a). The habitat of smooth coneflower is open woods, cedar barrens, roadsides, clearcuts, and powerline rights-of-way. Optimum sites are characterized by abundant sunlight and little competition in the herbaceous layer (USFWS 1992). Suitable habitat for this species occurs throughout SRS, including undeveloped land near E-Area.

Botanical surveys performed during 1992 and 1994 by the Savannah River Forest Station located four populations of rare plants in the area northwest of F-Area (Figure 4-4). One population of *Nestronia* and three populations of Oconee azalea (*Rhododendron flammeum*) were located on the steep slopes adjacent to the Upper Three Runs floodplain (LeMaster 1994b). The Oconee azalea is a state-listed rare species. *Nestronia* was a Federally-listed Category 2 species that was found to be more abundant than previously believed; consequently, it was determined that listing as threatened or endangered was not warranted (USFWS 1993).

Wood storks (*Mycteria americana*) feed in the Savannah River Swamp and the lower reaches of Steel Creek, Pen Branch, Beaver Dam Creek, and Fourmile Branch. They foraged at Par Pond during the drawdown in 1991 (Bryan 1992). The undeveloped land in E-Area contains no suitable foraging habitat, and wood storks have not been reported in this area (Coulter 1993). Bald eagles (*Haliaeetus*

*leucocephalus*) nest near Par Pond and L-Lake and forage on these reservoirs (USDA 1988; Brooks 1994). One bald eagle was reported flying near the junction of SRS Roads E and 4, south of H-Area, on November 15, 1985 (Mayer, Kennamer, and Hoppe 1986b). However, E-Area does not contain suitable nesting or foraging habitat for bald eagles. Peregrine falcons (*Falco peregrinus*) have been reported in the past as rare winter visitors to SRS near Par Pond. Kirtland's warbler (*Dendroica kirtlandii*) is also a rare temporary visitor (Wike et al. 1994). Shortnose sturgeon (*Acipenser brevirostrum*), typically residents of large coastal rivers and estuaries, have not been collected in the tributaries of the Savannah River that drain SRS. Sturgeon ichthyoplankton have been collected in the Savannah River near SRS (Wike et al. 1994).

The *Red-Cockaded Woodpecker Standards and Guidelines, Savannah River Site* (USDA 1991b) describes SRS management strategy for the red-cockaded woodpecker (*Picoides borealis*). The most important element of this management strategy is the conversion of slash (*P. elliotii*) (and some loblolly) pine in a designated red-cockaded woodpecker management area to longleaf pine, with a harvest rotation of 120 years. These birds inhabit and use open pine forests with mature trees (older than 70 years for nesting and 30 years for foraging) (Wike et al. 1994). While the undeveloped land surrounding E-Area contains no red-cockaded woodpecker nesting or foraging areas currently used by the species, it does contain unoccupied habitat of a suitable age (LeMaster 1994c).

As presented in Appendix J, DOE has consulted with the U.S. Fish and Wildlife Service to determine the potential for endangered species to be affected, as required by the Endangered Species Act.

**Table 3-9. Threatened, endangered, and candidate plant and animal species of SRS.a**

Common Name (Scientific Name)	Status <sup>b</sup>
Animals	
American sandburrowing mayfly ( <i>Dolania americana</i> )	FC2
Shortnose sturgeon ( <i>Acipenser brevirostrum</i> )	E
American alligator ( <i>Alligator mississippiensis</i> )	T/SA
Southern hognose snake ( <i>Heterodon simus</i> )	FC2
Northern pine snake ( <i>Pituophis melanoleucus melanoleucus</i> )	FC2
Carolina crawfish (= gopher) frog ( <i>Rana areolata capito</i> )	FC2
Loggerhead shrike ( <i>Lanius ludovicianus</i> )	FC2
Bachman's sparrow ( <i>Aimophila aestivalis</i> )	FC2
Bald eagle ( <i>Haliaeetus leucocephalus</i> )	E
Wood stork ( <i>Mycteria americana</i> )	E
Red-cockaded woodpecker ( <i>Picoides borealis</i> )	E
Peregrine falcon ( <i>Falco peregrinus</i> )	E
Kirtland's warbler ( <i>Dendroica kirtlandii</i> )	E

Bewick's wren ( <i>Thyromanes bewickii</i> )	FC2
Rafinesques (= southeastern) big-eared bat ( <i>Plecotus rafinesquii</i> )	FC2
Plants	
Smooth coneflower ( <i>Echinacea laevigata</i> )	E
Bog spice bush ( <i>Lindera subcoriacea</i> )	FC2
Boykin's lobelia ( <i>Lobelia boykinii</i> )	FC2
Loose watermilfoil ( <i>Myriophyllum laxum</i> )	FC2
Nestronia ( <i>Nestronia umbellula</i> )	FC3
Awnead meadowbeauty ( <i>Rhexia aristosa</i> )	FC2
Cypress knee sedge ( <i>Carex decomposita</i> )	FC2
Elliott's croton ( <i>Croton elliotii</i> )	FC2

a.Source: Wike et al. (1994).

b.FC2 = under review (a candidate species) for listing by the Federal Government.

FC3 = found to be more abundant than previously believed.

E = Federal endangered species.

T/SA = threatened due to similarity of appearance.

### 3.7 Land Use

SRS occupies approximately 800 square kilometers (300 square miles) in a generally rural area in western South Carolina. Administrative, production, and support facilities make up about 5 percent of the total SRS area. Of the remaining land, approximately 70 percent is planted pine forest managed by the U.S. Forest Service (under an interagency agreement with DOE), which harvests about 7.3 square kilometers (2.8 square miles) of timber from SRS each year (DOE 1993a). Approximately 57 square kilometers (22 square miles) of SRS have been set aside exclusively for nondestructive environmental research (DOE 1993a) in accordance with SRS's designation as a National Environmental Research Park. Research in the set-aside areas is coordinated by the University of Georgia's Savannah River Ecology Laboratory.

A number of factors will determine the future development and use of SRS. Primary among these are:

- funding and priority of DOE defense programs and environmental management activities
- decisions on the disposition of nuclear materials at SRS and other sites, which DOE is currently evaluating under the National Environmental Policy Act (NEPA)
- the role of SRS in the reconfigured DOE weapons complex, which is also being evaluated through the NEPA process
- possible alternative uses of SRS land, facilities, and human resources
- compliance with regulatory requirements concerning environmental protection, worker safety and health, and nuclear facility safety

- public input and participation
- community support (DOE 1994a)

Decisions on future land uses at SRS will be made by DOE through the site development, land-use, and future-use planning processes. There will be a study of each DOE site to determine possible uses. The study will address DOE missions and the public's perspectives and interests; and it will aid in deciding the most appropriate use for each site (DOE 1994a). SRS has established a Land Use Technical Committee composed of representatives from DOE, Westinghouse Savannah River Company, and other SRS organizations. The committee is evaluating potential uses for SRS. DOE prepared an *FY 1994 Draft Site Development Plan* (DOE 1994a), which describes the current SRS mission and facilities, evaluates possible future missions of SRS and their requirements, and outlines a master development plan now being prepared. In addition, DOE has projected requirements for land and other SRS resource needs for the next 20 years. This planning process must consider activities that will involve all DOE sites (e.g., reconfiguration of the nuclear weapons complex and strategies for spent nuclear fuel management) and SRS-specific actions (e.g., waste management and environmental restoration activities). The plan will take into account risks, benefits, possible final disposition of nuclear materials, potential facility decontamination and decommissioning, land-use strategies, cleanup standards, and facilities required for potential future missions. Once decisions on the future use of SRS have been made, appropriate cleanup levels will be determined and remediation techniques will be selected and submitted for regulatory approval.

### 3.8 Socioeconomics

This section discusses existing socioeconomic conditions within the "region of influence" where approximately 90 percent of the SRS workforce lived in 1992 (Figure 3-10). The SRS region of influence includes Aiken, Allendale, Bamberg, and Barnwell Counties in South Carolina, and Columbia and Richmond Counties in Georgia.

#### 3.8.1 Employment

Between 1980 and 1990, total employment in the SRS region of influence increased from 139,504 to 199,161, an average annual growth rate of approximately 4 percent. The unemployment rates for 1980 and 1990 were 7.3 percent and 4.7 percent, respectively (HNUS 1992). Table 3-10 lists projected employment data for the six-county region of influence. By 2025, regional employment is forecast to increase to approximately 269,000 (HNUS 1994).

#### Figure 3-10. Counties and cities within the SRS vicinity.

In fiscal year 1992, employment at SRS was 23,351, approximately 10 percent of regional employment, with an associated payroll of more than \$1.1 billion. SRS employment in 2000 is expected to decrease to approximately 15,800, representing 6 percent of regional employment, and it is expected to continue to decrease as a percent of regional employment in subsequent years.

#### **Table 3-10. Forecast employment, population, and personal income data for the SRS six-county**

**region of influence.a**

Year	Employment	Population	Personal Income (Billions)
1994	239,785	456,892	\$8.259
1995	242,033	461,705	\$8.770
2000	252,861	474,820	\$11.645
2005	267,138	479,663	\$15.608
2010	273,187	486,727	\$21.297
2015	274,541	497,226	\$28.771
2020	271,186	508,205	\$37.927
2025	268,659	517,080	\$50.194

a.Source: HNUS (1994).

### 3.8.2 Income

Personal income in the six-county region of influence increased from almost \$2.9 billion in 1980 to approximately \$6.9 billion in 1990. Together, Richmond and Aiken Counties accounted for 78 percent of personal income in the region of influence during 1991; these two counties provided most of the employment opportunities in the region. As listed in Table 3-10, personal income in the region is projected to increase 27 percent to almost \$8.8 billion in 1995 and to approximately \$50.2 billion by 2025 (HNUS 1994).

### 3.8.3 POPULATION

Between 1980 and 1990, population in the region of influence increased 13 percent, from 376,058 to 425,607. More than 88 percent of the 1990 population lived in Aiken (28.4 percent), Columbia (15.5 percent), or Richmond (44.6 percent) counties. Table 3-10 also presents population forecasts for the region of influence to 2025 (HNUS 1994). According to census data, the average number of persons per household in the six-county region of influence was 2.72 in 1990, and the median age was 31.2 years (HNUS 1992).

### 3.8.4 COMMUNITY INFRASTRUCTURE AND SERVICES

Public education facilities in the six-county region of influence include 95 elementary or intermediate schools and 25 high schools. In addition to the public schools, there are 42 private and 16 post-secondary schools in the region (HNUS 1992).

The average number of students per teacher in 1988 was 16, based on a combined average daily attendance for elementary and high school students in the region of influence. The highest ratio was in Columbia County high schools, where there were 19 students per teacher (1987/1988 academic year). The lowest ratio occurred in Barnwell County's district 29 high school, which had 12 students per teacher (1988/1989 academic year) (HNUS 1992).

The six-county region of influence has 14 major public sewage treatment facilities with a combined design capacity of 302.2 million liters (79.8 million gallons) per day. In 1989, these systems were operating at approximately 56 percent of capacity, with an average daily flow of 170 million liters (44.9 million gallons) per day. Capacity utilization ranged from 45 percent in Aiken County to 80 percent in Barnwell County (HNUS 1992).

There are approximately 120 public water systems in the region of influence. About 40 of these county and municipal systems are major facilities, while the remainder serve individual subdivisions, water districts, trailer parks, or miscellaneous facilities. In 1989, the 40 major facilities had a combined total flow of 576.3 million liters (152.2 million gallons) per day. With an average daily flow rate of approximately 268.8 million liters (71 million gallons) per day, these systems were operating at 47 percent of total capacity in 1989. Facility utilization rates ranged from 13 percent in Allendale County to 84 percent in the City of Aiken (HNUS 1992).

Eight general hospitals operate in the six-county region of influence, with a combined capacity in 1987 of 2,433 beds (5.7 beds per 1,000 population). Four of the eight general hospitals are in Richmond County; Aiken, Allendale, Bamberg, and Barnwell Counties each have one general hospital. Columbia County has no hospital. In 1989, there were approximately 1,295 physicians serving the regional population, which represents a physician-to-population ratio of 3 to 1,000. This ratio ranged from 0.8 physician per 1,000 people in Aiken and Allendale counties to 5.4 physicians per 1,000 people in Richmond County (HNUS 1992).

Fifty-six fire departments provide fire protection in the region of influence. Twenty-seven of these are classified as municipal fire departments, but many provide protection to rural areas outside municipal limits. The average number of firefighters in the region in 1988 was 3.8 per 1,000 people, ranging from 1.6 per 1,000 in Richmond County to 10.2 per 1,000 in Barnwell County (HNUS 1992).

County sheriff and municipal police departments provide most law enforcement in the region of influence. In addition, state law enforcement agents and state troopers assigned to each county provide protection and assist county and municipal officers. In 1988, the average ratio in the region of influence of full-time police officers employed by state, county, and local agencies per 1,000 population was 2.0. This ratio ranged from 1.4 per 1,000 in Columbia County to 2.5 per 1,000 in Richmond County (HNUS 1992).

### **3.8.5 DEMOGRAPHIC CHARACTERISTICS**

Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," requires that Federal agencies identify and address, as appropriate, disproportionate adverse human health or environmental effects of their programs and activities on people of color and the poor. DOE is developing official guidance on the implementation of the

Executive Order. This eis's approach to implementing the Order is to identify the potential effects of waste management activities at SRS on people of color or those with low incomes. The following describes the analysis of environmental justice issues for the alternatives considered in this eis. Potential offsite health impacts would result from releases to the air and to the Savannah River. For air releases, standard population dose analyses are based on an 80-kilometer (50-mile) radius from SRS because expected dose levels beyond that distance are very small. Table 3-11 and Figure 3-11 provide data on the 1990 population distribution within a 80-kilometer (50-mile) radius of SRS. For releases to water, the region of analysis includes areas along the Savannah River that draw on it for drinking water [Beaufort and Jasper Counties in South Carolina and Port Wentworth (Savannah), Georgia]. Therefore, the analysis examines populations in all census tracts that have at least 20 percent of their area within the 80-kilometer (50-mile) radius of SRS and all tracts from Beaufort and Jasper Counties in South Carolina and Effingham and Chatham Counties in Georgia. It should be noted that offsite health effects are based on the population within an 80-kilometer (50-mile) radius of SRS and those people who use the Savannah River for drinking water. The population considered in estimating drinking water dose is beyond the 80-kilometer (50-mile) radius. DOE used data from each census tract in this combined region to identify the racial composition of communities and the number of persons characterized by the U.S. Bureau of the Census as living in poverty. The combined region of analysis contains 247 census tracts, 99 in South Carolina and 148 in Georgia.

**Figure 3-11. Cities and towns within an 80-kilometer (50-mile) radius of SRS.**

Tables 3-12 and 3-13 list racial and economic characteristics of the population within the combined region. The total population in the combined area is more than 993,000. Of that total population, approximately 618,000 (62.2 percent) are white. Within the population of people of color (375,000), approximately 94 percent are African American; the remainder are Asian, Hispanic, or Native American. Figure 3-12 gives the distribution of people of color by census tract areas within the region of analysis.

Executive Order 12898 does not define minority populations. However, one approach is to identify communities that contain a simple majority of people of color (greater than or equal to 50 percent of the total population of the community). A second approach, proposed by EPA, defines communities of people of color as those that have higher-than-average (over the region of analysis) percentages of people of color (EPA 1994). In Figure 3-12, two different shadings indicate census tracts where (1) people of color constitute 50 percent or more of the total population in the tract, or (2) people of color constitute between 35 percent and 50 percent of the total population in the tract. For purposes of this analysis, DOE adopted the second, more expansive, approach to identifying minority populations.

In the combined region, there are 80 tracts (32.4 percent) where the number of people of color are equal to or greater than 50 percent of the total population. In an additional 50 tracts (20.2 percent), people of color comprise between 35 and 49 percent of the population. These tracts are well distributed throughout the region, although there are more of them toward the south and in the immediate vicinities of Augusta and Savannah, Georgia.

Low-income communities are defined as those in which 25 percent or more of the population live in poverty (EPA 1993b). The U.S. Bureau of the Census defines persons in poverty as those with incomes less than a "statistical poverty threshold." This threshold is a weighted average based on family size and the age of the persons in the family. The baseline threshold for the 1990 census was an income of \$8,076 for a family of two during the previous year, 1989.

In the region of analysis, more than 169,000 persons (17.0 percent of the total population) live in poverty (Table 3-13). In Figure 3-13, shaded census tracts identify low-income communities. In the region, 72 tracts (29.1 percent) are low-income communities. These tracts are distributed throughout the region of analysis, but are primarily to the south and west of SRS.

**Figure 3-12. Distribution of people of color by census tracts in the SRS region of analysis.**

**Figure 3-13. Low income census tracts in the SRS region of analysis.**

**Table 3-11. Population distribution in 1990 within an 80-kilometer (50-mile) radius of SRS.a**

Kilometers <sup>b</sup>							
Direction	0-8	8-16	16-32	32-48	48-64	64-80	Total
N	0	26	5,321	10,020	5,067	12,210	32,620
NNE	0	6	1,320	2,066	4,445	14,370	22,200
NE	0	1	2,945	2,928	5,269	10,200	21,340
ENE	0	27	3,126	4,483	5,337	40,770	53,740
E	0	155	6,743	5,305	8,812	4,334	25,350
ESE	0	36	1,556	1,931	2,711	3,253	9,487
SE	0	26	547	6,511	6,685	8,577	22,350
SSE	0	40	391	769	1,356	2,539	5,095
S	0	1	558	1,332	7,251	3,335	12,480
SSW	0	2	897	2,008	4,181	2,944	10,030
SW	0	17	944	2,240	2,606	2,660	8,467
WSW	0	60	1,103	7,112	2,285	5,818	16,380
W	0	55	3,314	7,941	7,994	6,780	26,080
WNW	0	449	3,342	106,900	50,310	11,550	172,500
NW	0	271	5,899	87,930	26,570	3,025	123,700
NNW	0	363	18,030	27,160	6,665	6,079	58,300
Total	0	1,535	56,040	276,600	147,500	138,400	620,100

a. Source: Arnett (1993).

b. To convert to miles, multiply by 0.6214.

**Table 3-12. General racial characteristics of the population in the region of analysis.a**

State	Total population	White	African American	Hispanic	Asian	Native American	Other	People of color	Percent people of color <sup>b</sup>
SC	418,685	267,639	144,147	3,899	1,734	911	335	151,046	36.08%
GA	574,982	350,233	208,017	7,245	7,463	1,546	478	224,749	39.09%
Total	993,667	617,872	352,164	11,144	9,197	2,457	833	375,795	37.82%

a.Source: U.S. Bureau of the Census (1990a).

b.Methodologies used to collect census data result in situations in which the total population does not equal the sum of the populations of the identified racial groups. In this table, people of color is calculated by subtracting the white population from the total population.

**Table 3-13. Percentage of the population living in poverty in the region of analysis.a**

Area	Total population	Persons living in poverty <sup>b</sup>	Percent living in poverty
SC	418,685	72,345	17.28%
GA	574,982	96,672	16.81%
Total	993,667	169,017	17.01%

a.Source: U.S. Bureau of the Census (1990b).

b.Families with incomes less than \$8,076 in 1989 for a family of two.

### 3.9 Cultural Resources

#### 3.9.1 ARCHAEOLOGICAL SITES AND HISTORIC STRUCTURES

Field studies conducted over the past two decades by the South Carolina Institute of Archaeology and Anthropology of the University of South Carolina, under contract to DOE and in consultation with the South Carolina State Historic Preservation Officer, have provided considerable information about the distribution and content of archaeological and historic sites on SRS. By the end of September 1992, approximately 60 percent of SRS had been examined, and 858 archaeological (historic and prehistoric) sites had been identified. Of these, 53 have been determined to be eligible for the National Register of Historic Places; 650 have not been evaluated. No SRS facilities have been nominated for the National Register of Historic Places, and there are no plans for nominations at this time. The existing SRS nuclear production facilities are not likely to be eligible for the National Register of Historic Places, either because they lack architectural integrity, do not represent a particular style, or do not contribute to the broad historic theme of the Manhattan Project and the

production of initial nuclear materials (Brooks 1993, 1994).

Archaeologists have divided SRS into three zones related to their potential for containing sites with multiple archaeological components or dense or diverse artifacts, and their potential for nomination to the National Register of Historic Places (SRARP 1989).

- Zone 1 is the zone of the highest archaeological site density, with a high probability of encountering large archaeological sites with dense and diverse artifacts, and a high potential for nomination to the National Register of Historic Places.
- Zone 2 includes areas of moderate archaeological site density. Activities in this zone have a moderate probability of encountering large sites with more than three prehistoric components or that would be eligible for nomination to the National Register of Historic Places.
- Zone 3 includes areas of low archaeological site density. Activities in this zone have a low probability of encountering archaeological sites and virtually no chance of encountering large sites with more than three prehistoric components; the need for site preservation is low. Some exceptions to this definition have been discovered in Zone 3; some sites in the zone could be considered eligible for nomination to the National Register of Historic Places.

S- and Z-Areas were extensively surveyed prior to construction of the Defense Waste Processing Facility. No archaeological or historic artifacts were found (DOE 1982). The construction of F- and H-Areas during the 1950's is likely to have destroyed any historic or archaeological resources in those areas (Brooks 1993).

### 3.9.2 Native American Cultural Resources and Concerns

In conjunction with studies in 1991 related to the New Production Reactor, DOE solicited the concerns of Native Americans about religious rights in the Central Savannah River Valley. During this study, three Native American groups, the Yuchi Tribal Organization, the National Council of Muskogee Creek, and the Indian People's Muskogee Tribal Town Confederacy, expressed general concerns about SRS and the Central Savannah River Area, but did not identify specific sites as possessing religious significance. The Yuchi Tribal Organization and the National Council of Muskogee Creek are interested in several plant species traditionally used in tribal ceremonies, such as redroot (*Lachnanthes carolinianum*), button snakeroot (*Eryngium yuccifolium*), and American ginseng (*Panax quinquefolium*) that may occur on SRS (NUS 1991a). Redroot and button snakeroot are known to occur on SRS (Batson, Angerman, and Jones 1985). DOE included all three tribal organizations on its mailing lists and sends them documents about SRS environmental activities.

### 3.10 Aesthetics and Scenic Resources

The dominant aesthetic settings in the vicinity of SRS are agricultural land and forest, with some limited residential and industrial areas. The reactors and most of the large facilities are located in the interior of SRS (Figure 3-2). Because of the distance to the SRS boundary, the rolling terrain, normally hazy atmospheric conditions, and heavy vegetation, SRS facilities are not usually visible from outside SRS or from roads with public access. The few locations that have views of some SRS structures (other than the administrative area) are distant from the structures [8 kilometers (5 miles)

or more]; these views have low visual sensitivity levels because most of these structures were built as many as 40 years ago and are well established in the viewer's expectations.

SRS land is heavily wooded (predominantly pine forest, which minimizes seasonal differences), and developed areas occupy approximately 5 percent of the total land area. The facilities are scattered across SRS and are brightly lit at night. Typically, the reactors and principal processing facilities are large concrete structures as much as 30 meters (100 feet) tall adjacent to shorter administrative and support buildings and parking lots. These facilities are visible in the direct line-of-sight when approaching them on SRS access roads. The only structure visible from a distance is the recently completed K-Reactor Cooling Tower. Since this tower will not be operated, the absence of a steam plume ensures no further visual impact. Otherwise, heavily wooded areas that border the SRS road system and public highways crossing the Site limit views of the facilities.

### **3.11 Traffic and Transportation**

#### **3.11.1 REGIONAL INFRASTRUCTURE**

SRS is surrounded by a system of interstate highways, U.S. highways, state highways, and railroads. Barge traffic is possible on the Savannah River; however, neither SRS nor commercial shippers routinely use barges (DOE 1991). Figure 3-14 shows the regional transportation infrastructure.

#### **3.11.2 SRS TRANSPORTATION INFRASTRUCTURE**

The SRS transportation infrastructure consists of more than 230 kilometers (143 miles) of primary roads, 1,931 kilometers (1,200 miles) of unpaved secondary roads, and 103 kilometers (64 miles) of railroad track (WSRC 1993c). These roads and railroads provide connections among the various SRS facilities and links to offsite transportation. Figure 3-15 shows the SRS network of primary roadways, access points, and the SRS railroad system.

##### **3.11.2.1 SRS Roads**

In general, heavy traffic occurs in the early morning and late afternoon when workers commute to and from SRS. Table 3-14 provides data on SRS roads during peak travel times, and Table 3-15 provides peak baseline traffic for the primary offsite access roads and Road E. During working hours, official vehicles and logging trucks constitute most of the traffic. As many as 30 logging trucks, which can impede traffic, may be operating simultaneously on SRS, with an annual average of 15 trucks per day (WSRC 1992a). A total of 785 trucks longer than about 8 meters (25 feet) enter and exit SRS daily (Swygert 1994a).

##### **3.11.2.2 SRS Railroads**

The SRS rail yard is east of P-Reactor. This eight-track facility sorts and redirects rail cars. Deliveries of shipments to SRS occur at two rail stations in the former towns of Ellenton and Dunbarton. From these stations, an SRS engine moves the railcars to the appropriate facility. The Ellenton station, which is on the main Augusta-Yemassee line, receives coal for the large powerhouse located in D-Area. The Dunbarton station receives the other rail shipments and coal for the smaller powerhouses located throughout SRS (McLain 1994).

**Figure 3-14. SRS regional transportation infrastructure.**

**Figure 3-15. Location of principal SRS facilities, roads, and railroads.**

Under normal conditions, about 13 trains per day use the CSX tracks through SRS (Burns 1993). Movement of coal and casks containing radioactive material constitutes the bulk of rail traffic (DOE 1991).

**Table 3-14. Traffic counts on major SRS roads.a**

Measurement point	Date	Direction	Daily total	Peak <sup>b</sup>	Peak time <sup>c</sup>	Average speed (mph) <sup>d</sup>
Road 2 between Roads C and D	9-29-93 9-29-93	East West	3,224 3,225	794 897	1530 0630	52 47
Road 4 between Roads E and C	12-9-92 12-9-92	East West	1,624 1,553	352 306	1530 0615	NA <sup>e</sup> NA
Road 8 at Pond C	2-23-92 2-23-92	East West	634 662	274 331	1530 0615	58 56
Road C between landfill and Road 2	12-16-92 12-16-92	North South	6,931 6,873	2,435 2,701	1530 0630	53 58
Road C north of Road 7	1-20-93 1-20-93	North South	742 76 3	288 223	0630 1530	45 47

Road D at old gunsite	9-29-93	North	1,779	218	1500	43
	9-29-93	South	1,813	220	0845	52
Road E at E-Area	8-25-93	North	3,099	669	1530	35
	8-25-93	South	3,054	804	0630	38
Road F at Upper Three Runs	2-2-93	North	3,239	1,438	1530	53
	2-2-93	South	3,192	1,483	0630	51
Road F north of Road 4	8-25-93	North	3,097	1,239	1530	NA
	8-25-93	South	255	75	0645	39
Road F south of Road 4	8-25-93	North	126	41	0645	29
	8-25-93	South	290	68	0645	35

a. Source: Swygert (1994b).

b. Number of vehicles in peak hour.

c. Start of peak hour.

d. mph = miles per hour; to convert to kilometers per hour, multiply by 1.6093.

e. NA = not available.

**Table 3-15. Traffic counts on major SRS arteries during peak hours (vehicles per hour).**

Road	Design capacity	1994 baseline traffic <sup>a</sup>	Percent of capacity
Offsite <sup>a</sup>			
SC 19	3,000 <sup>b</sup>	2,800 <sup>b</sup>	93
SC 125	3,200 <sup>b</sup>	2,700 <sup>b</sup>	84
SC 57	2,100 <sup>b</sup>	700 <sup>c</sup>	33
Onsite <sup>a,d</sup>			
Road E at E-Area	2,300 <sup>c</sup>	741 <sup>e</sup>	32

a. Baseline traffic for 1994 was estimated from actual traffic counts measured in 1989 (offsite) and 1992/1993 (onsite) by adjusting total vehicles by the percent of change in SRS employment between the measured years and 1994.

b. Adapted from Smith (1989).

- c. Adapted from TRB (1985).
  - d. Source: Swygert (1994b).
  - e. Morning traffic traveling to E-Area.
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### **3.11.3 noise**

Previous studies have assessed noise impacts of existing SRS operational activities (NUS 1991b; DOE 1990, 1991). These studies concluded that, because of the remote locations of the SRS operational areas, there are no known conditions associated with existing sources of noise at SRS that adversely affect individuals at offsite locations.

## **3.12 Occupational and Public Radiological Health and Safety**

### **3.12.1 PUBLIC RADIOLOGICAL Health**

A release of radioactivity to the environment from a nuclear facility is an important issue for both SRS workers and the public. However, the environment contains many sources of radiation, and it is important to understand all the sources of ionizing radiation to which people are routinely exposed.

#### **3.12.1.1 Sources of Environmental Radiation**

Environmental radiation consists of natural background radiation from cosmic, terrestrial, and internal body sources; radiation from medical diagnostic and therapeutic practices; radiation from weapons tests fallout; radiation from consumer and industrial products; and radiation from nuclear facilities. All radiation doses mentioned in this EIS are "effective dose equivalents" (i.e., organ doses are weighted for biological effect to yield equivalent whole-body doses) unless specifically identified otherwise (e.g., "absorbed dose," "thyroid dose," "bone dose").

Releases of radioactivity to the environment from SRS account for less than 0.1 percent of the total annual average environmental radiation dose to individuals within 80 kilometers (50 miles) of SRS (Arnett, Karapatakis, and Mamatey 1994). Standard population dose analyses for air releases are based on an 80-kilometer (50-mile) radius because expected dose levels beyond that distance are very small.

Natural background radiation contributes about 82 percent of the annual dose of 357 millirem received by an average member of the population within 80 kilometers (50 miles) of SRS (Figure 3-16). Based on national averages, medical exposure accounts for an additional 15 percent of the annual dose, and the combined doses from weapons tests fallout, consumer and industrial products, and air travel account for about 3 percent of the total dose (NCRP 1987a).

External radiation from natural sources comes from cosmic rays and emissions from natural radioactive materials in the ground. The radiation dose from external radiation varies with location and altitude.

Internal radiation from natural terrestrial sources consists primarily of potassium-40, carbon-14, rubidium- 87, and daughter products of radium-226 that are consumed in food grown with fertilizers containing these radionuclides. The estimated average internal radiation exposure in the United States from natural radioactivity (primarily indoor radon daughter products) is 240 millirem per year (NCRP 1987b).

Medical radiation is the largest source of man-made radiation to which the population of the United States is exposed. The average dose to an individual from medical and dental x-rays, prorated over the entire population, is 39 millirem per year (NCRP 1987a). In addition, radiopharmaceuticals administered to patients for diagnostic and therapeutic purposes account for an average annual dose of 14 millirem when prorated over the population. Thus, the average medical radiation dose in the U.S. population is about 53 millirem per year. Prorating the dose over the population determines an average dose that, when multiplied by the population size, produces an estimate of population exposure. It does not mean that every member of the population receives a radiation exposure from these sources.

In 1980, the estimated average annual dose from fallout from nuclear weapons tests was 4.6 millirem (0.9 millirem from external gamma radiation and 3.7 millirem from ingested radioactivity). Because atmospheric nuclear weapons tests have not been conducted since 1980, the average annual dose from fallout is now less than 1 millirem. This decline is due principally to radioactive decay.

A variety of consumer and industrial products yield ionizing radiation or contain radioactive materials and, therefore, result in radiation exposure to the general population. Some of these sources are televisions, luminous dial watches, airport x-ray inspection systems, smoke detectors, tobacco products, fossil fuels, and building materials. The estimated average annual dose for the U.S. population from these sources is 10 millirem per year (NCRP 1987a). About one-third of this dose is from external exposure to naturally occurring radionuclides in building materials.

### **Figure 3-16. Major sources of radiation exposure in the vicinity of SRS.**

People who travel by aircraft receive additional exposure from cosmic radiation because at high altitudes the atmosphere provides less shielding from this source of radiation. The average annual airline passenger dose, when prorated over the entire U.S. population, amounts to 1 millirem (NCRP 1987b).

#### **3.12.1.2 Radiation Levels in the Vicinity of SRS**

Figure 3-16 summarizes the major sources of exposure for the population within 80 kilometers (50 miles) of SRS and for populations in Beaufort and Jasper Counties, South Carolina, and in Chatham County, Georgia, that drink water from the Savannah River. Many factors, such as natural background dose and medical dose, are independent of SRS.

Atmospheric testing of nuclear weapons deposited approximately 25,600,000 curies of cesium-137 on the earth's surface (United Nations 1977). About 104 millicuries of cesium-137 per square kilometer were deposited in the latitude band where South Carolina is located (30°N to 40°N). The total resulting deposition was 2,850 curies on the 27,400 square kilometers (10,580 square miles) of the Savannah River watershed and 80 curies on SRS. The cesium-137 attached to soil particles and has slowly been transported from the watershed. Results from routine health protection monitoring programs indicate that since 1963 about 1 percent of the 2,850 curies of cesium-137 deposited on the total Savannah River watershed has been transported down the Savannah River (du Pont 1983).

Onsite monitoring shows that an average of 50 millicuries of cesium-137 per square kilometer (1976 to 1982 average) are in the upper 5 centimeters (2 inches) of the soil column. This is one-half the original amount. Some of the cesium has moved down in the soil column, and some has been transported in surface water to the Savannah River.

Other nuclear facilities within 80 kilometers (50 miles) of SRS include a low-level waste burial facility operated by Chem-Nuclear Systems, Inc., near the eastern SRS boundary, and Georgia Power Company's Vogtle Electric Generating Plant, located directly across the Savannah River from SRS. In addition, Carolina Metals, Inc., which is northwest of Boiling Springs in Barnwell County, South Carolina, processes depleted uranium. The Chem-Nuclear facility, which began operating in 1971, releases essentially no radioactivity to the environment (Chem-Nuclear Systems, Inc. 1980), and the population dose from normal operations is very small. The 80-kilometer (50-mile) radius population receives an immeasurably small radiation dose from transportation of low-level radioactive waste to the burial site. Plant Vogtle began commercial operation in 1987, and its releases to date have been far below DOE guidance levels and Nuclear Regulatory Commission regulatory requirements (Davis, Martin, and Todd 1989).

In 1993, releases of radioactive material to the environment from SRS operations resulted in a site perimeter maximum dose from all pathways from atmospheric releases of 0.11 millirem per year (in the north- northwest sector), and a maximum dose from releases into water of 0.14 millirem per year, for a maximum total annual dose at the SRS perimeter of 0.25 millirem (Arnett, Karapatakis, and Mamatey 1994). The maximum dose to downstream consumers of Savannah River water was to users of the Port Wentworth public water supply, and was 0.05 millirem per year (Arnett, Karapatakis, and Mamatey 1994).

In 1990, the population within 80 kilometers (50 miles) of SRS was 620,100 (Arnett, Karapatakis, and Mamatey 1993 and Table 3-11). The collective effective dose equivalent to the 80-kilometer (50-mile) population in 1993 was 7.6 person-rem from atmospheric releases (Arnett, Karapatakis, and Mamatey 1994). The 1990 population of 65,000 people using water from Port Wentworth (Savannah), Georgia, and from Beaufort and Jasper Counties, South Carolina, received a collective dose equivalent of 1.5 person-rem (Arnett, Karapatakis, and Mamatey 1994).

Controlled deer and hog hunts are conducted annually at SRS to control their populations. Field measurements performed on each animal prior to release to the hunter determine the levels of cesium-137 present in the animal. Field measurements are subsequently verified by laboratory analysis, and dose calculations are performed to estimate dose to the maximally exposed individual among the hunters. In 1993, the maximally exposed individual hunter killed four deer and three hogs. The dose to this hunter was estimated based on the cesium-137 measurements of the deer and hog muscle taken from these animals and the conservative assumption that the hunter consumed all of the edible

portions of these animals (337 pounds of meat). The dose to this maximally exposed individual was estimated to be 57 millirem (Arnett, Karapatakis, and Mamatey 1994), which represents 57 percent of the DOE annual limit of 100 millirem (DOE Order 5400.5).

In 1993, the maximally exposed individual fisherman was assumed to eat 19 kilograms (42 pounds) of fish per year. The dose to the fisherman was based on consumption of fish taken only from the mouth of Steel Creek on SRS. The dose to this individual was estimated to be 1.30 millirem (WSRC 1994a) or 1.3 percent of the DOE annual limit (DOE 1993a).

The hunter population dose was estimated based on the fact that 1,553 deer and 147 hogs were killed in 1993. These deer and hogs contained average cesium-137 concentrations of 4.69 picocuries per gram and 5.64 picocuries per gram, respectively. The regional average of cesium-137 concentration in deer is 0.7 picocuries per gram (Fledderman 1994). The population dose due to the consumption of SRS animals is estimated to be 8.3 person-rem. The portion of this dose attributable to the presence of cesium-137 above the regional average concentration is 7.1 person-rem (Rollins 1994).

Gamma radiation levels, including natural background terrestrial, and cosmic radiation measured at 179 locations around the SRS perimeter during 1993, yielded a maximum dose rate of 102 millirem per year (Arnett, Karapatakis, and Mamatey 1994). This level is typical of normal background gamma levels measured in the general area (84 millirem per year measured by the EPA at Augusta, Georgia, in 1992). The maximum gamma radiation level measured onsite (N-Area) was 460 millirem per year (Arnett, Karapatakis, and Mamatey 1994).

Detailed summaries of releases to the air and water from SRS are provided in a series of annual environmental reports (e.g., Arnett, Karapatakis, and Mamatey 1994 for the year 1993). Each of these environmental reports also summarizes radiological and nonradiological monitoring and the results of the analyses of environmental samples. These reports also summarize the results of the extensive groundwater monitoring at SRS, which uses more than 1,600 wells to detect and monitor both radioactive and nonradioactive contaminants in the groundwater and drinking water in and around process operations, burial grounds, and seepage basins.

### **3.12.1.3 Radiation Levels in E-, F-, H-, N-, S-, and Z-Areas**

Table 3-16 presents gamma radiation levels measured in E-, F-, H-, N-, S-, and Z-Areas in 1993. These values can be compared to the average dose rate of 35 millirem per year measured at the SRS perimeter. This difference is attributable to differences in geologic composition, as well as facility operations.

Analyses of soil samples from uncultivated areas measure the amount of particulate radioactivity deposited from the atmosphere. Table 3-17 lists maximum measurements of radionuclides in the soil for 1993 at E-, F-, H-, S-, and Z-Areas, the SRS perimeter, and at background [160-kilometer (100-mile)] monitoring locations. Measured elevated concentrations of strontium-90 and plutonium-239 around F- and H-Areas reflect releases from these areas.

### **Table 3-16. External radiation levels (milliRoentgen per year) at SRS facilities.a,b**

Location	Average	Maximum
E-Area	158	345
F-Area	91	126
H-Area	103	146
N-Area	178	460
S-Area	101	117
Z-Area	72	80

a. Source: Arnett (1994).

b. One milliRoentgen is approximately 1 millirem.

**Table 3-17. Maximum measurements of radionuclides in soil for 1993 [picocuries per gram; 0 to 8 centimeters (0 to 3 inches) depth].<sup>a</sup>**

Location	Strontium-90	Cesium-137	Plutonium-238	Plutonium-239
F-Area	0.133	1.26	0.0784	0.360
H-Area	0.0863	1.57	0.0262	0.178
S-Area	0.0331	0.353	0.0355	0.0540
Z-Area	0.0825	0.820	0.00663	0.0504
E-Area	0.0264	0.271	(b)	(b)
Site perimeter	0.0095	0.652	0.00187	0.0201
Background [160-kilometer (100-mile) radius]	0.0772	0.352	0.00105	0.00835

a. Source: Arnett (1994).

b. No data available.

### 3.12.2 WORKER RADIATION EXPOSURE

The major goals of the SRS Health Protection Program are to keep the exposure of workers to radiation and radioactive material within safe limits and, within those limits, as low as reasonably achievable. An effective radiation protection program must minimize doses to individual workers and the collective dose to all workers in a given work group.

#### 3.12.2.1 Sources of Radiation Exposure to Workers at SRS

Worker dose comes from exposure to external radiation or from internal exposure when radioactive material enters the body. In most SRS facilities, the predominant source of worker exposure is from external radiation. In the SRS facilities that process tritium, the predominant source of worker exposure is the internal dose from tritium that has been inhaled or absorbed into internal body fluids. On rare occasions, other radionuclides can contribute to internal dose if they have accidentally been inhaled or ingested.

External exposure comes mostly from gamma radiation emitted from radioactive material in storage containers or process systems (tanks and pipes). Neutron radiation, which is emitted by a few special radionuclides, also contributes to worker external radiation in a few facilities. Beta radiation, a form of external radiation, has a lesser impact than gamma and neutron radiation because it has lower penetrating energy and, therefore, produces a dose only to the skin, rather than to critical organs within the body. Alpha radiation from external sources does not have an impact because it has no penetrating power.

Internal exposure occurs when radioactive material is inhaled, ingested, or absorbed through the skin. Once the radioactive material is inside the body, low-energy beta and non-penetrating alpha radiation emitted by the radioactive material in close proximity to organ tissue can produce dose to that tissue. If this same radioactive material were outside the body, the low penetrating ability of the radiation emitted would prevent it from reaching the critical organs. For purposes of determining health hazards, organ dose can be converted to effective dose equivalents. The mode of exposure (internal versus external) is irrelevant when comparing effective dose equivalents.

#### **3.12.2.2 Radiation Protection Regulations and Guidelines**

The current SRS radiological control program implements Presidential Guidance issued to all Federal agencies on January 20, 1987. This guidance was subsequently codified (10 CFR 835) as a federal regulation governing all DOE activities (58 FR 238). Policies and program requirements, formulated to ensure the protection of SRS workers and visitors, are documented in the *SRS Radiological Control Procedure Manual, WSRC 5Q* (WSRC 1993d). DOE performs regular assessments to ensure the continuing quality and effectiveness of the SRS radiological control program by monitoring radiological performance indicators and by making periodic independent internal appraisals as required by 10 CFR 835.102. External appraisals are also conducted periodically by DOE and the Defense Nuclear Facilities Safety Board to provide additional assurance of continuing program effectiveness.

Appropriate control procedures, engineered safety systems, and worker training programs are established and implemented to ensure compliance with applicable regulations before beginning radioactive operation of any facility at the SRS.

#### **3.12.2.3 SRS Worker Dose**

The purpose of the radiation protection program is to minimize dose from external and internal

exposure; it must consider both individual and collective dose. It would be possible to reduce individual worker dose to very low levels by using numerous workers to perform extremely small portions of the work task. However, frequent changing of workers would be inefficient and would result in a higher total dose received by all the workers than if fewer workers were used and each worker were allowed to receive a slightly higher dose.

Worker doses at SRS have consistently been well below the DOE worker exposure limits. Administrative exposure guidelines are set at a fraction of the exposure limits to help ensure doses are as low as reasonably achievable. For example, the current DOE worker exposure limit is 5 rem per year, and the SRS administrative exposure guideline was 1.5 rem per year in 1993. Table 3-18 shows the maximum and average individual doses and the SRS collective doses for 1988 through 1993.

**Table 3-18. SRS annual individual and collective radiation doses.a**

Year	Individual dose (rem)		SRS collective dose (person-rem)
	Maximum	Average <sup>b</sup>	
1988	2.040	0.070	864
1989	1.645	0.056	754
1990	1.470	0.056	661
1991	1.025	0.038	392
1992	1.360	0.049	316
1993	0.878	0.051	263

a. Adapted from: du Pont (1989), WSRC (1991, 1992b, 1993d, 1994a), Petty (1993).

b. The average dose is calculated only for workers who received a measurable dose during the year.

#### 3.12.2.4 Worker Risk

In the United States, 23.5 percent of human deaths each year are caused by some form of cancer (CDC 1993). Any population of 5,000 people is expected to contract approximately 1,200 fatal cancers from non-occupational causes during their lifetimes, depending on the age and sex distribution of the population. Workers who are exposed to radiation have an additional risk of 0.0004 latent fatal cancers per person-rem of radiation exposure (NCRP 1993).

In 1993, 5,157 SRS workers received a measurable dose of radiation amounting to 263 person-rem (Table 3-18). Therefore, this group may experience up to 0.1 ( $0.0004 \times 263$ ) additional cancer death due to its 1993 occupational radiation exposure. Continuing operation of SRS could result in up to 0.1 additional cancer death each year of operation, assuming future annual worker exposure continues at the 1993 level. In other words, for each 10 years of operation, there could be one additional death from cancer among the work force that receives a measurable dose at the 1993 level.

### 3.12.3 WORKER NONRADIOLOGICAL SAFETY AND HEALTH

Industrial safety, industrial hygiene, medical monitoring, and fire protection programs have been implemented at SRS to ensure the nonradiological health and safety of SRS workers.

The Occupational Safety and Health Administration requires the use of incidence rates to measure worker safety and health (DOL 1986). Incidence rates relate the number of injuries and illnesses and the resulting days lost from work to exposure (i.e., the number of hours worked) of workers to workplace conditions that could result in injuries or illnesses. Incidence rates, which are based on the exposure of 100 full-time workers working 200,000 hours (100 workers times 40 hours per week times 50 weeks per year), automatically adjust for differences in the hours of worker exposure. The Occupational Safety and Health Administration also specifies the types of injuries and illnesses that must be recorded for inclusion in incidence rate calculations. Incidence rates are generally calculated for total number of recordable cases, total number of lost workday cases, and total number of lost workdays.

Each year, the Bureau of Labor Statistics reports the results of its annual survey of job-related injuries and illnesses in private industry. The injury and illness data supplied by the Bureau of Labor Statistics provide the most comprehensive survey data available on work-related injuries and illnesses in private industry. The Bureau of Labor Statistics estimates that in 1991, private industry employers experienced 8.4 work-related injuries and illnesses per 100 full-time workers (DOE 1993b).

Incidence rates provide an objective measure of the performance of SRS safety programs. The data in Table 3-19 compare the performance of SRS operations to that of general industry, the manufacturing industry, and the chemical industry (DOE 1993a). SRS safety programs have produced incidence rates that are far below comparable rates for general industry, the manufacturing industry, and the chemical industry. The numbers reported in Table 3-19 for SRS include only management and operating contractor employers because these are the only ones that would be involved in waste management.

Occupational exposure to noise is controlled through the management and operating contractor hearing conservation program outlined in Industrial Hygiene Manual 4Q, Procedure 501. This program implements the contractor requirements for identifying, evaluating, and controlling noise exposures to meet the requirements of 29 CFR 1910.95, Occupational Noise Exposure.

**Table 3-19. Comparison of 1992 illness and injury incidence rates for SRS operations to 1991 illness and injury incidence rates for general industry, the manufacturing industry, and the chemical industry (number of illnesses and injuries per 100 full-time workers).**

Incidence rate	SRS M&O <sup>a</sup> operations	General industry	Manufacturing industry	Chemical industry
Total recordable cases	0.5	8.4	12.7	6.4
Lost workday cases	0.1	3.9	5.6	3.1

Lost workdays	2.0	86.5	121.5	62.4
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a. M&O = management and operating contractor.

### 3.13 Waste and Materials

SRS activities in support of the national defense mission produced liquid high-level radioactive waste, low-level (low- and intermediate-activity) radioactive waste, hazardous waste, mixed waste (radioactive and hazardous combined), and transuranic waste. This section discusses current treatment, storage, and disposal of these wastes at SRS and management of wastes generated from facility operations discussed in Chapter 2.

Wastes at SRS were and continue to be generated both by facility operations and environmental restoration, with facility operations generating most of the waste. Facility operations include nuclear and non-nuclear research; material testing; laboratory analysis; high-level waste processing and nuclear fuel storage; manufacturing, repair, and maintenance; and general office work. Facility operations also include operating all waste management facilities for treatment, storage, and disposal of SRS-generated wastes.

DOE treats, stores, and disposes of wastes generated from all onsite operations in waste management facilities, most of which are located in E-, F-, H-, N-, S-, and Z-areas (Figure 3-2). Major facilities include the high-level waste tank farms; the Low-Level Radioactive Waste Disposal Facility; the F- and H-Area Effluent Treatment Facility; the Defense Waste Processing Facility (undergoing startup testing); and the Consolidated Incineration Facility (under construction).

The environmental restoration mission has increased in recent years and includes two programs: (1) the decontamination and decommissioning of surplus facilities (see Section 3.14) and (2) the remediation program, which identifies and, where necessary, arranges for cleanup of potential releases from inactive waste sites (see Section 3.15).

DOE stores liquid and solid wastes at SRS. Liquid high-level radioactive waste is stored in underground storage tanks in accordance with an SCDHEC wastewater treatment permit (Figures 3-17 and 3-18). The tanks are managed in accordance with federal laws, SCDHEC regulations, and DOE Orders. Figure 3-19 shows the management process for liquid high-level radioactive waste at SRS. Transuranic mixed waste is stored on interim-status storage pads in accordance with SCDHEC requirements and DOE Orders (Figure 3-20). Wastewater contaminated with low-level radioactivity is stored and treated at the F/H-Area Effluent Treatment Facility, a SCDHEC permitted facility (Figure 3-21). Hazardous and mixed wastes are stored in permitted or interim-status facilities, such as the hazardous waste storage facilities (buildings and pads) and in the mixed waste storage buildings (Figures 3-22 and 3-23, respectively). Figure 3-24 shows the process for handling other forms of waste at SRS.

**Figure 3-17.**

**Figure 3-18.**

**Figure 3-19.**

**Figure 3-20.**

**Figure 3-21.**

**Figure 3-22.**

**Figure 3-23.**

**Figure 3-24.**

Through waste minimization and treatment programs, DOE continues to reduce the amount of waste generated, stored, and disposed of at SRS. DOE minimizes waste by reducing its volume, toxicity, or mobility before storage and disposal. Waste reduction includes intensive surveys, waste segregation, and the use of administrative and engineering controls.

### **3.13.1 Low-Level Radioactive Waste**

Low-level radioactive waste is defined as waste that contains radioactivity and is not classified as high-level waste, transuranic waste, spent nuclear fuel, or byproduct material.

SRS packages low-level waste for disposal onsite in the Low-Level Radioactive Waste Disposal Facility (Figure 3-25) according to its waste category and its estimated surface dose. DOE places low-activity wastes in carbon steel boxes and deposits them in low-activity waste vaults in E-Area. The vaults are concrete structures approximately 200 meters (643 feet) long by 44 meters (145 feet) wide by 8 meters (27 feet) deep.

DOE packages intermediate-activity waste according to its form and disposes of it in intermediate-level waste vaults in E-Area. Some intermediate-activity waste, such as contaminated pieces of equipment, is wrapped in canvas before disposal.

DOE will store long-lived wastes, such as resins, in the Long-Lived Waste Storage Building in E-Area until DOE develops treatment and disposal technologies for them (Figure 3-26).

The E-Area vaults began receiving low-level radioactive waste in September 1994. This facility includes low-activity, intermediate-level nontritium, and intermediate-level tritium vaults (Figures 3-27 and 3-28).

### **3.13.2 LIQUID HIGH-LEVEL RADIOACTIVE WASTE**

Liquid high-level radioactive waste is highly radioactive material from the reprocessing of spent nuclear fuel that contains a combination of transuranic waste and fission products in concentrations requiring permanent isolation. It includes both the liquid waste produced by reprocessing and any

solid waste derived from that liquid. The solid waste is also classified as liquid high-level radioactive waste.

**Figure 3-25**

**Figure 3-26.**

**Figure 3-27.**

**Figure 3-28.**

SRS generates liquid high-level radioactive waste during the recovery of nuclear materials from spent fuel and targets in F- and H-Areas, and stores it in 50 underground tanks. Waste was previously stored in an additional tank; however, waste in that tank has been removed, and the tank is no longer in service. These tanks also contain other radioactive effluents (primarily low-level radioactive waste such as liquid process waste and purge water from storage basins for irradiated reactor fuel or fuel elements). The liquid high-level waste is neutralized and then stored in these tanks until short-lived radionuclides have decayed to inconsequential levels and insoluble components of the waste (about 5 to 10 percent) have settled out to form a sludge layer on the tank bottom. The liquid waste is then heated to evaporate the water, thereby reducing its volume and crystallizing the solids as salt. The *Final Supplemental Environmental Impact Statement Defense Waste Processing Facility* (DOE 1994b) provides details on this process. The evaporated liquid is transferred to the F/H-Area Effluent Treatment Facility, which is designed to decontaminate routine process effluents from F- and H-Areas. The salt fraction is further processed by in-tank precipitation to separate it into a highly radioactive portion for vitrification at the Defense Waste Processing Facility (when it becomes operational) and a low radioactive salt solution that is stabilized and disposed of at the Z-Area Saltstone Facility.

### 3.13.3 Transuranic Waste

Transuranic waste contains alpha-emitting radionuclides that have an atomic weight greater than uranium (92), half-lives greater than 20 years, and concentrations greater than 100 nanocuries per gram of waste. Before 1982, transuranic waste was defined as any waste containing transuranic radionuclides with concentrations in excess of 10 nanocuries per gram. Buried and stored wastes containing concentrations of transuranic radionuclides between 10 and 100 nanocuries per gram are now referred to as alpha-contaminated low-level waste (or "alpha waste" in this eis). Alpha waste is managed like transuranic waste because its physical and chemical characteristics are similar and because similar procedures will be used to determine its final disposition. SRS stores waste containing 10 to 100 nanocuries of alpha activity per gram with transuranic wastes until disposal requirements can be determined. Currently, there are no treatment facilities or disposal capacities for transuranic waste; however, DOE plans to retrieve, repackage, certify, and ship all transuranic wastes offsite for final disposition.

Historically, DOE used three types of retrievable storage for transuranic waste at SRS. Transuranic waste generated before 1974 is buried in approximately 120 below-grade concrete culverts in the Low-Level Radioactive Waste Disposal Facility. Transuranic waste generated between 1974 and 1986 is stored on five concrete pads and one asphalt pad that have been covered with approximately

1.2 meters (4 feet) of native soil. DOE stores waste generated since 1986 on 13 concrete pads that are not covered with soil. Transuranic waste includes waste mixed with hazardous waste which is stored on Pads 1 through 17 that operate under interim status approved by SCDHEC (Figures 3-20 and 3-29). DOE currently uses Pads 18 and 19 to manage nonhazardous transuranic wastes only. DOE filed for approval under a RCRA Part A permit application (to describe the waste and facilities) for additional storage of transuranic mixed waste on Pads 20 through 22, which are currently empty. All of these pads are located in the Low-Level Radioactive Waste Disposal Facility.

### 3.13.4 Hazardous Waste

Hazardous waste is defined as any discarded materials that are either characteristically hazardous or are listed as hazardous under RCRA. Characteristically hazardous materials are corrosive, ignitable, reactive, or toxic. Wastes listed as hazardous include certain process wastes, solvents, and discarded commercial chemicals.

At SRS, hazardous waste is generated by routine facility operations and environmental restoration projects. Hazardous waste is temporarily stored at storage facilities (Figure 3-22) located in new buildings in B- and N-Areas, prior to shipment to permitted treatment, storage, and disposal facilities.

DOE began offsite shipments of hazardous wastes to treatment and disposal facilities in 1987. In 1990, DOE imposed a moratorium on shipments of hazardous waste that came from radiological materials areas or that had not been proven to be nonradioactive. SRS continues to send hazardous waste that is confirmed as not subject to the moratorium (e.g., recyclable solvents) offsite for recycling, treatment, or disposal.

### 3.13.5 Mixed Waste

Mixed waste contains both hazardous waste (subject to RCRA), and source, special nuclear, or byproduct material (subject to the Atomic Energy Act of 1954). Mixed waste is classified according to its radioactive component. Low-level mixed waste is managed with its hazardous components as its primary consideration, while high-level and transuranic mixed wastes are managed with their radioactive component as the primary consideration.

The SRS mixed waste program consists primarily of safely storing mixed wastes until treatment and disposal facilities are available. Mixed waste storage facilities are located in E-Area (Figure 3-23), N-Area, M-Area, S-Area, and A-Area. These facilities include Burial Ground Solvent Tanks S23 through S30, M-Area Process Waste Interim Treatment/Storage Facility (Figure 3-30), Savannah River Technology Center Mixed Waste Storage Tanks, and the Organic Waste Storage Tank (Figure 3-31).

**Figure 3-29.**

**Figure 3-30.**

**Figure 3-31.**

DOE has also requested approval under RCRA for interim storage capacity at a pad in M-Area for treated M- Area sludge and stabilized ash and blowdown waste from the Consolidated Incineration Facility.

DOE is constructing the Consolidated Incineration Facility in H-Area to treat mixed, low-level, and hazardous waste. The Consolidated Incineration Facility is designed to annually process approximately 17,830 cubic meters (630,000 cubic feet) of solid waste (e.g., boxed mixed, low-level, or hazardous waste) at 50 percent utility and approximately 4,630 cubic meters (163,610 cubic feet) of liquid waste (e.g., liquid hazardous, mixed, and low-level waste) at 70 percent utility (Figure 3-32).

### **3.13.6 Hazardous Materials**

The *SRS Tier Two Emergency and Hazardous Chemical Inventory Report* (WSRC 1994b) for 1993 lists more than 225 hazardous chemicals that were present at some time during the year in excess of their respective minimum threshold level (10,000 pounds for hazardous chemicals and 500 pounds or less for extremely hazardous substances). Ten of these hazardous chemicals are designated as extremely hazardous substances under the Emergency Planning and Community Right-to-Know Act of 1986. The actual number and quantity of hazardous chemicals present on SRS, as well as at individual facilities, change daily as inventories are used and replenished. The annual reports filed under the Superfund Amendments and Reauthorization Act for the SRS facilities include year-to-year inventories of these chemicals.

## **3.14 Decontamination and Decommissioning**

### **3.14.1 Decontamination and Decommissioning Programs**

The objective of the decontamination and decommissioning programs at SRS is to plan and implement the surveillance, maintenance, and cleanup of contaminated areas that are no longer needed by DOE. The program's goal is to ensure that risks to human health and safety and to the environment posed by these areas are eliminated or reduced to safe levels in a timely and cost-effective manner. This goal will be accomplished by cleaning up and reusing facilities, returning sites to greenfield conditions (in which the facility, its foundation, and the contaminated soil would be removed), or entombing facilities in concrete. The methods selected will determine the quantities of waste materials needing disposal. Decontamination and decommissioning methods have not been identified for most SRS facilities; the selection process would be subject to separate NEPA review. This section describes the surplus areas that will eventually be decontaminated and decommissioned and estimates the amount of waste that will be generated by decontamination and decommissioning.

#### **Figure 3-32.**

There are more than 6,000 buildings at SRS that will eventually be declared surplus and will need to

be decommissioned. As of April 1994, 2,862 of these facilities had been identified as surplus (WSRC 1994c). Two-hundred-thirty-four of the buildings are now surplus or will be within 5 years. Some of these facilities may be used in new missions, but others pose risks unless they are properly maintained and decommissioned.

SRS prepared a 30-year forecast of the amounts of wastes that would be generated by decontamination and decommissioning (WSRC 1994d). This forecast was based on a 5-year forecast that identified 53 facilities to be decontaminated and decommissioned between 1995 and 1999. Both forecasts relied on the Surplus Facility Inventory and Assessment Database dated March 4, 1994, which contains information on SRS facilities such as building size, type of construction, radiological characterization, and hazardous material characterization. The database is continuously updated as new information becomes available.

Facilities that need to be decontaminated and decommissioned have been categorized according to the types of work required (WSRC 1994e). These categories will ensure incorporation of on-the-job lessons learned and assignment of specialized work crews to similar projects across SRS. The following sections describe some tentative categories of facilities with common traits or factors.

#### **3.14.1.1 Asbestos Abatement Program**

Two-hundred-eleven buildings contain asbestos, including 142 buildings for which asbestos is the only contaminant present. The R-Area surplus buildings are the first ones scheduled for asbestos removal. Experience at these facilities will improve asbestos abatement at other SRS facilities.

#### **3.14.1.2 Decommissioning Program for Higher-Risk Facilities**

Most of the surplus buildings have only small amounts of contamination. However, a few surplus facilities have more contamination, pose risks of releasing contaminants under special circumstances, or are located near large numbers of employees or near the SRS boundary. These facilities have been given a priority for immediate decontamination and decommissioning and are assigned to the higher risk facilities decommissioning program. Facilities in this program include the Separations Equipment Development Facility, the 235-F Plutonium Fabrication Facility, and the 232-F Tritium Manufacturing Building.

#### **3.14.1.3 Decommissioning Program for Nuclear Reactor Facilities**

The buildings associated with nuclear reactors are included in the nuclear reactor facilities decommissioning program. The Heavy Water Component Test Reactor is the prototype for this program. By starting with a small facility, DOE can learn from experience and develop methods and procedures which will then be applied to the larger reactors.

#### **3.14.1.4 Decommissioning Program for High-Level Waste Storage Tanks**

Fifty-one high-level waste storage tanks and their ancillary equipment will eventually be decommissioned. Type I, II, and IV tanks will be closed in place once the waste (supernatant, saltcake, and sludge) stored in the tanks has been removed, prior to decontamination and decommissioning. Decontamination and decommissioning activities will include stabilizing residual waste, removing associated equipment and small buildings, and abandoning in place underground transfer lines and diversion boxes. Type III tanks, which have secondary containment, will be used during the waste vitrification process at the Defense Waste Processing Facility, which is expected to continue for 24 years. To date, waste has been removed from one high-level waste storage tank.

#### **3.14.1.5 Decommissioning Program for Separations Facilities**

The separations facilities present the greatest challenge for decontamination and decommissioning because of their size, high levels of contamination, need for security, and process complexity. The transition of these facilities from operational status to one suitable for final disposition will require a long and expensive sequence of activities. The Separations Equipment Development facility (located within the Savannah River Technology Center) was shut down in 1978 and transferred to the DOE environmental restoration decontamination and decommissioning program in 1982 (see Section 3.14.1.2). Lessons learned from the decontamination and decommissioning of this facility will be used to develop procedures for the larger chemical separations facilities in F- and H-Areas.

#### **3.14.1.6 Decommissioning Program for Waste Handling Facilities**

Waste handling facilities will process waste generated by decontamination and decommissioning. The decontamination and decommissioning of these facilities cannot begin until this processing has been completed. However, there are a number of obsolete waste handling facilities that can be decommissioned sooner.

#### **3.14.1.7 Decommissioning Program for Miscellaneous Facilities**

Facilities that do not fit into other categories are included in the miscellaneous facilities category. At this time only a few facilities (in M-, N-, and Z-Areas) have been assigned to this category. Other unique facilities will probably be added to the miscellaneous facilities category. Decontamination and decommissioning of these areas is not scheduled to begin until 1998.

### **3.14.2 Decontamination and Decommissioning Waste Generation**

Decontamination and decommissioning will generate large amounts of waste for a long period of time. These wastes will include equipment, rubble, contaminated clothing, and tools. Most of the quantitative data regarding waste generated by decontamination and decommissioning have been collected during the dismantling of plutonium production and processing facilities. The volumes of

waste generated by decontaminating and decommissioning these facilities is expected to represent an upper estimate of the amount of waste generated because of the high contamination levels and special packaging requirements inherent in transuranic waste.

For plutonium-238 facilities, approximately 13 cubic meters (459 cubic feet) of solid waste per square meter (10.76 square feet) of contaminated floor area are generated by decontamination and decommissioning. Of this, approximately 50 percent is transuranic waste; the rest is low-level waste. Less than 0.03 cubic meters (1.05 cubic feet) is mixed waste (primarily lead shielding) per square meter of area (Smith and Hootman 1994; Hootman and Cook 1994).

For plutonium-239 processing facilities, approximately 4 cubic meters (141 cubic feet) of transuranic waste and 5 cubic meters (177 cubic feet) of low-level waste are generated per square meter (10.76 square feet) of contaminated floor during decontamination and decommissioning (Hootman and Cook 1994).

### **3.15 Environmental Restoration**

The fundamental goal of environmental restoration at SRS is to ensure that the environment is protected from further degradation caused by past activities, and that the safety and health of people exposed to the environment are protected. This goal is met through the cleanup of inactive facilities. "Cleanup" refers to actions taken to prevent the release or potential release of hazardous substances to the environment. These actions may involve complete removal of the substances from the environment; or stabilizing, containing, or treating the substances so that they do not affect human health or the environment.

In accordance with Section 120 of the Comprehensive Environmental Response, Compensation and Liability Act, DOE negotiated a Federal Facility Agreement with EPA and SCDHEC that organizes remedial activities at SRS into one comprehensive strategy that fulfills both RCRA corrective action requirements, including closure and post-closure of RCRA-regulated units, and Comprehensive Environmental Response, Compensation, and Liability Act investigation and remedial action requirements. Environmental restoration of inactive waste sites at SRS is controlled by the Federal Facility Agreement. The number of sites to be assessed and considered for cleanup under the Federal

Facility Agreement is estimated to be 420. Newly identified sites are still being added to Appendix G of the Federal Facility Agreement. Sites are listed in the following Federal Facility Agreement appendixes:

- Appendix C - Sites with known releases
- Appendix G - Sites with potential releases to be investigated
- Appendix H - Sites subject to RCRA

Each of these lists appears in Appendix G of this eis.

To date, DOE has prepared approximately 55 work plans detailing the proposed investigations for RCRA/Comprehensive Environmental Response, Compensation, and Liability Act units identified in Appendix C of the Federal Facility Agreement. These work plans must be approved by EPA and SCDHEC prior to implementation. Eleven of the work plans have been approved. Additional site

characterization and field sampling is underway at these units.

Of the 304 areas identified on the original Site Evaluation List (Appendix G of the Federal Facility Agreement), DOE has prepared site evaluation reports for 36 and received EPA and SCDHEC concurrence on 17 of the proposed response actions. Six closures of RCRA-regulated units (Appendix H of the Federal Facility Agreement) have been completed and approved by SCDHEC.

Each cleanup and closure will generate significantly different quantities of waste materials. Specific cleanup methods have not been identified for most of the SRS waste sites. The methods will be selected in accordance with procedures established by the Federal Facility Agreement and will be subject to separate NEPA review. The remainder of this section discusses the extent and type of site contamination in E-Area and hazardous and mixed waste sites.

### **3.15.1 Surface and Groundwater Quality**

Contamination of the shallow groundwater aquifers beneath the SRS with industrial solvents, metals, tritium, and other constituents, and contamination of the surface waters with tritium are discussed in Sections 3.3 and 3.4, respectively.

### **3.15.2 Hazardous and Mixed Waste Sites**

Six types of waste units are common to SRS. The descriptions for these waste sites are derived from Arnett, Karapatakis, and Mamatey (1993).

#### **3.15.2.1 Acid/Caustic Basins**

The acid/caustic basins found in F-, H-, K-, L-, P-, and R-Areas are unlined earthen pits, approximately 15 meters by 15 meters by 2 meters (50 feet by 50 feet by 7 feet) deep, that received dilute sulfuric acid and sodium hydroxide solutions used to regenerate ion-exchange units. Other wastes discharged to the basins included water rinses from the ion-exchange units, steam condensate, and runoff from containment enclosures for storage tanks. The dilute solutions are mixed and neutralized in the basins before they are discharged to nearby streams. Constituents identified as exceeding standards in monitoring wells near the acid/caustic basins include lead, cadmium, sulfates, nitrates, tritium, gross alpha radioactivity, nonvolatile beta radioactivity, technetium-99, and total dissolved solids (Arnett, Karapatakis, and Mamatey 1993).

The basins were constructed between 1952 and 1954. The R-Area basin was abandoned in 1964, the L-Area basin in 1968, and the H-Area basin not until 1985. The other basins remained in service until new neutralization facilities became operational in 1982. The basins will be remediated in accordance with requirements of the Federal Facility Agreement; however, SRS and SCDHEC have not determined the level of cleanup that will be required.

### 3.15.2.2 Burning/Rubble Pits

From 1951 to 1973, wastes such as paper, wood, plastics, rubber, oil, degreasers, and drummed solvents were burned in one of the burning/rubble pits in A-, C-, D-, F-, K-, L-, N- (Central Shops), P-, or R-Areas. In 1973, the burning of waste stopped, and the bottoms of the pits were covered with soil. Rubble wastes including paper, wood, concrete, and empty galvanized-steel barrels and drums were then disposed of in the pits until they reached capacity and were covered with soil. All dumping into burning/rubble pits stopped by 1982, and all are covered except the R-Area pit, which has not been backfilled. These pits will be remediated in accordance with requirements of the Federal Facility Agreement. Work plans to fully characterize the extent of contamination at all of the pits have been submitted to EPA and SCDHEC. Constituents identified as exceeding standards in monitoring wells near the burning/rubble pits include lead and volatile organics (Arnett, Karapatakis, and Mamatey 1993).

### 3.15.2.3 Coal Pile Runoff Containment Basins

Electricity and steam at SRS are generated by burning coal, which is stored in open piles. The coal is generally moderate-to-low sulfur coal (1 to 2 percent), which is received by rail, placed on a hopper, sprayed with water to control dust, and loaded onto piles. Coal piles originally existed in A-, C-, D-, F-, H-, K-, L-, P-, and R-Areas. The coal pile in R-Area was removed in 1964, the L-Area coal pile was removed in 1968, and the coal piles in C- and F- Areas were removed in 1985. In 1991, the K-Area coal pile was reduced to a 2-inch base, and 75 percent of the P- Area coal pile was also removed. Constituents identified as exceeding standards in monitoring wells near the former coal piles include gross alpha radioactivity, nonvolatile beta radioactivity, volatile organics, sulfates, tritium, total dissolved solids, and lead (Arnett, Karapatakis, and Mamatey 1993).

The coal piles generally contained a 90-day reserve of coal, which was not rotated; this resulted in long-term exposure to the weather. Chemical and biological oxidation of sulfur compounds in the coal during this weathering resulted in the formation of sulfuric acid.

To comply with the National Pollutant Discharge Elimination System permit issued in 1977, DOE built runoff containment basins around the coal piles in A- and D-Areas in October 1978, and around the coal piles in the C-, F-, H-, K-, and P-Areas in March 1981.

Currently, rainwater runoff from the remaining coal piles in several areas (A, D, H, K, and P) flows into the coal pile runoff containment basins via ditches and sewers. The basins allow mixing of the water runoff with seepage below the surface, thus preventing the discharge of large surges of low pH (acidic) runoff into streams. All the basins are functional, including those in C- and F-Areas which still collect runoff, although no coal remains at either location. These basins will be remediated in accordance with requirements of the Federal Facility Agreement.

### 3.15.2.4 Disassembly Basins

Disassembly basins were constructed adjacent to each reactor to store irradiated reactor fuel and target rods prior to their shipment to the separations areas. The disassembly basins are concrete-lined

tanks containing water. Although the irradiated assemblies were rinsed before being placed in the basins, some radioactivity was released to the water from the film of liquid on the irradiated components, the oxide corrosion film on the irradiated components, and infrequently, from leaks in porous components. Sand filters were used to remove radioactive particulates from the disassembly basin water. Filtered basin water was circulated through chemical filters (deionizers) to remove additional constituents and was periodically purged through regenerated deionizers to the reactor seepage basins. The disassembly basin then was filled with clean water.

Constituents identified as exceeding standards in monitoring wells near the disassembly basins include lead, tritium, and alkalinity (as calcium carbonate) (Arnett, Karapatakis, and Mamatey 1993). The disassembly basins will be remediated in accordance with the Federal Facility Agreement.

#### **3.15.2.5 Reactor Seepage Basins**

Since 1957, active reactor seepage basins have received purged water with low-level radioactivity from disassembly basins. This water purge is necessary to keep the tritium concentration in disassembly basin water within safe levels for operating personnel. Although many radionuclides have been discharged to the basins, almost all of the radioactivity is due to tritium and small amounts of strontium-90, cesium-137, and cobalt-60. Constituents identified as exceeding standards in monitoring wells near the reactor seepage basins include alkalinity (as calcium carbonate), lead, tritium, gross alpha radioactivity, nonvolatile beta radioactivity, nitrates, volatile organics, mercury, potassium-40, and strontium-90 (Arnett, Karapatakis, and Mamatey 1993).

Before the use of sand filters began in the 1960s (see Section 3.15.2.4), purge water was pumped directly from the disassembly basins to the seepage basins. From 1970 to 1978, the seepage basins for active reactors were bypassed, and the filtered, deionized purge water was discharged directly into nearby streams. In 1978, the seepage basins for C-, L-, and P-Reactors were reactivated. The K-Reactor Seepage Basin was used from 1957 to 1960 only. The R-Area seepage basins have been filled and covered with asphalt. The K- and R-Area Reactor seepage basins will be remediated in accordance with the Federal Facility Agreement.

#### **3.15.2.6 Sewage Sludge Application Sites**

Beginning in 1980, the sewage sludge application sites were the subject of a research program using domestic sewage sludge to reclaim borrow pits and to enhance forest productivity. After sludge was applied to the sites according to the provisions of a SCDHEC permit, hardwoods and pines were planted to determine whether sludge could be used as a fertilizer and soil amendment to increase wood production. Constituents identified as exceeding standards in monitoring wells near these sites include gross alpha radioactivity, nonvolatile beta radioactivity, radium-226, radium-228, and lead (Arnett, Karapatakis, and Mamatey 1993). These sludge application sites will be remediated in accordance with the Federal Facility Agreement. Work plans to fully characterize the extent of contamination at the K-Area and Par Pond sites have been submitted to EPA and SCDHEC.

#### **3.15.3 Burial Ground Complex**

The Burial Ground Complex (E-Area) occupies about 1.3 square kilometers (330 acres) in the central part of SRS between F- and H-Areas. The Burial Ground Complex is divided into a northern area containing 1 square kilometer (254 acres) and a southern area containing 0.3 square kilometer (76 acres). The southern area is known as the Old Radioactive Waste Burial Ground; it was a trench disposal area that began receiving waste in 1952 and was filled in 1972. After 1973, wastes were disposed of in the northern disposal area (Figure 3-33).

Disposal in the northern area of the Burial Ground Complex, referred to as the Low-Level Radioactive Waste Disposal Facility, continues. In 1986, it was determined that hazardous wastes may have been placed in certain areas of the Low-Level Radioactive Waste Disposal Facility. These areas were designated as the Mixed Waste Management Facility (Figure 3-33). Since that time, DOE has determined that additional areas of the Low-Level Radioactive Waste Disposal Facility contain solvent rags; these areas have been added to the Mixed Waste Management Facility. The Mixed Waste Management Facility includes shallow, unlined trenches in which various low-level radioactive wastes containing solvents and metals were placed. A RCRA Closure Plan was approved by SCDHEC for the original Mixed Waste Management Facility in 1987; closure was completed in December 1990, and SCDHEC issued the closure certification in April 1991. Closure of the portions of the Mixed Waste Management Facility that contain the solvent rags is pending.

**Figure 3-33.**

Hazardous substances, including cadmium, lead, mercury, tritium, and volatile organic compounds, have been detected in groundwater beneath the Mixed Waste Management Facility. The shallow aquifer contains levels of tritium, trichloroethylene, and tetrachloroethylene that exceed EPA's primary drinking water standards (Figures 3-33 and 3-34).

**Figure 3-34. Trichloroethylene and tetrachloroethylene contamination in the shallow aquifer under E-Area on the SRS.**

### 3.16 References

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## CHAPTER 4. ENVIRONMENTAL CONSEQUENCES

This chapter describes the impacts of waste management activities on the environment (described in Chapter 3) at the Savannah River Site (SRS), including the construction and operation of new facilities (described in Chapter 2). As described in Chapter 2, 10 scenarios are evaluated. The no-action alternative (see Section 2.2) is evaluated first (Section 4.1). In Section 4.2, alternative A (limited treatment configuration; see Section 2.4) is evaluated for the expected, minimum, and maximum amounts of waste forecast for SRS. In Section 4.3, alternative C (extensive treatment configuration; see Section 2.5) is evaluated for the same three forecasts. Section 4.4 analyzes alternative B (moderate treatment configuration; see Section 2.6), which incorporates a mix of technologies being considered by the U.S. Department of Energy (DOE) for the different waste types. The three alternatives place different degrees of emphasis on the objectives of the proposed action. DOE believes that these alternatives represent the full range of reasonable alternatives and has identified alternative B as the preferred alternative.

This chapter also discusses potential cumulative impacts from alternative B when it is added to impacts from past, present, and reasonably foreseeable actions and presents the unavoidable adverse impacts and irreversible or irretrievable commitment of resources under alternative B. Cumulative impacts were assessed only for the moderate treatment configuration alternative B B expected waste forecast because the impacts for it generally fall between those for the other alternatives, and because impacts do not vary greatly between alternatives. Despite some variation in impacts, this approach allowed for an assessment of the likely magnitudes of the cumulative impacts of the other alternatives based on the cumulative impacts of alternative B. Appendix B.5 examines the impacts of processing low-level, hazardous, and mixed wastes in the Consolidated Incineration Facility under alternatives A, B, and C.

Impacts are assessed in terms of direct physical disturbance or consumption of affected resources and as the effects of effluents and emissions on the chemical and physical quality of the environment. When annual data (such as annual doses) are presented, they are based on the calendar year rather than the fiscal year. Assessments focus on impacts to such natural resources as air, water, and plants and animals, as well as on human resources, including the health of workers and the public, and socioeconomics.

	Min.	Exp.	Max.
No Action			
A			
B			
C			

To aid the reader, the same stacked-box symbol used in Chapter 2 is used in Chapter 4. For example, a section that begins with the symbol shown at left is discussing alternative A B minimum waste forecast.

	Min.	Exp.	Max.
No Action			
A			
B			
C			

## 4.1 No Action

This section discusses the effects of the no-action alternative described in Section 2.2.

### 4.1.1 Introduction

Under the no-action alternative, which continues current practices to manage waste, DOE would:

- Continue waste minimization activities as described in Section 2.2.1.
- Continue receiving and storing liquid high-level waste in the F- and H-Area tank farms and begin removing it for treatment at the Defense Waste Processing Facility and associated facilities.
- Continue operating the existing liquid high-level waste evaporators and operate the Replacement High-Level Waste Evaporator presently under construction.
- Operate the Defense Waste Processing Facility and associated liquid high-level waste management facilities as described in *Final Supplemental Environmental Impact Statement, Defense Waste Processing Facility* (DOE/eis-0082S) and its Record of Decision (60 FR 18589).
- Continue to compact some low-level waste using the three existing compactors.
- Continue to dispose of low-level wastes in vaults and by shallow land disposal.
- Store certain low-level wastes in long-lived waste storage buildings.
- Continue to store naval hardware on pads in E-Area with possible shallow land disposal.
- Continue to store hazardous wastes until they are sent for offsite treatment and disposal.
- Continue to treat aqueous hazardous wastes collected from groundwater monitoring well operations (investigation-derived wastes) in the M-Area Air Stripper.
- Continue offsite treatment and disposal of PCB wastes.
- Continue to store mixed wastes and construct additional storage for them.
- Continue to treat mixed wastes by ion exchange in the tanks at the Savannah River Technology Center.
- Construct and operate the M-Area Vendor Treatment Facility and use it to vitrify mixed wastes from M-Area electroplating operations, as discussed in the *Environmental Assessment, Treatment of M-Area Mixed Wastes at the Savannah River Site* (DOE/ea-0918).
- Continue to treat aqueous mixed wastes collected from groundwater monitoring wells (investigation-derived waste) in the F/H-Area Effluent Treatment Facility.
- Continue to store radioactive PCB wastes with planned offsite treatment of the PCB fraction and onsite shallow land disposal of the radioactive residuals.
- Construct and operate Resource Conservation and Recovery Act (RCRA)-permitted disposal vaults for disposal of residuals from the treatment of mixed waste, as evaluated in *Final*

*Environmental Impact Statement, Waste Management Activities for Groundwater Protection, Savannah River Plant (DOE/eis-0120).*

- Continue to store transuranic and alpha wastes on transuranic waste storage pads, retrieve waste drums from mounded storage pads, and construct additional waste storage capacity.
- Perform facility upgrades and continue to operate the Experimental Transuranic Waste Assay Facility/Waste Certification Facility to characterize transuranic and alpha wastes.
- Dispose of newly-generated nonmixed alpha waste in low-activity waste vaults.
- Continue to construct the Consolidated Incineration Facility.

The locations of these waste management facilities are identified in Figure 4-1.

**Figure 4-1. Location of SRS waste management facilities under the no-action alternative.**

The no-action alternative requires additional storage facilities for transuranic and alpha waste and additional disposal areas for low-level radioactive waste and mixed waste in the vicinity of the existing vaults in E-Area. New mixed waste storage facilities would be constructed in the area between the Low-Level Radioactive Waste Disposal Facility and the M-Line railroad. A portion of this area has been cleared, graded, and stabilized with vegetation to prevent erosion. Additional undisturbed lands located (1) adjacent to and south of the M-Line railroad and (2) northwest of F-Area would be required for the remainder of the mixed waste storage facilities (Figure 4-2).

Construction for the no-action alternative would require 0.35 square kilometer (86 acres) of undeveloped land northwest of F-Area and 0.30 square kilometer (74 acres) of undeveloped land between the Low-Level Radioactive Waste Disposal Facility and M-Line railroad. Other construction would be on previously cleared and developed land in the eastern part of E-Area.

	Min.	Exp.	Max.
No Action			
A			
B			
C			

#### 4.1.2 GEOLOGIC RESOURCES

Under the no-action alternative, impacts to geologic resources can be evaluated by comparing the amounts of land needed to build the facilities for this alternative. The more land required for the facilities, the greater the impacts, namely soil erosion, on these resources.

Except for some small gravel deposits, there are no economically valuable minerals or unique geologic features located in the vicinity of the waste management areas considered in this alternative, or any of the other alternatives. Waste management activities in the no-action alternative would mainly impact soils in the uncleared parts of E-Area. Construction would have less impact on soils in those parts of E-Area where the land has been cleared of trees and already disturbed by the construction of existing buildings. In E-Area, approximately 0.33 square kilometer (81 acres) has been cleared and developed, and approximately 0.65 square kilometer (160 acres) would be cleared to build additional vaults, storage pads, tanks, and buildings (Figure 4-2).

The undisturbed soils in E-Area have a slight to moderate erosion hazard rating (USDA 1990). That

is, erosion could occur if site preparation activities, such as grading, expose these soils and no precautions are taken to prevent erosion. Most of the soils in the cleared parts of E-Area consist of spoil from excavated areas, borrow pits, and previous grading activities; these soils also have a slight to moderate erosion hazard rating. The potential for erosion and sedimentation effects increases as the amount of land needed for construction increases, especially undeveloped land.

**Figure 4-2. Configuration of treatment, storage, and disposal facilities in E-Area under the no-action alternative by the year 2024.**

Potential adverse effects to geologic resources would be very small and could be mitigated by installing sediment and erosion control devices, properly grading slopes, and stabilizing the site. All new construction activities at SRS must comply with state regulations to prevent erosion. As a condition of the South Carolina Department of Health and Environmental Control (SCDHEC) National Pollutant Discharge Elimination System general permit for stormwater discharges from construction activities at SRS, a stormwater pollution prevention plan (WSRC 1993a) must be developed for each construction site covered by the permit, and each plan must provide for erosion and sediment controls. E-Area erosion and sediment control activities are addressed in the *Solid Waste Operations Erosion and Sedimentation Control Maintenance Program Plan - E-Area* (WSRC 1992a). For those areas already cleared and ready for construction of new facilities and those areas already operating, proper construction and maintenance of sediment ponds, stormwater basins, and other erosion and sediment control devices would mitigate adverse effects to soils during operation of waste management facilities.

Construction and operation activities might produce accidental occasional spills (e.g., oil, fuel, and process chemicals) on the soil. SRS has formal spill prevention, control, and countermeasures plans to prevent, identify, and mitigate spills of petroleum products (WSRC 1991a, b). Both the *Savannah River Site Best Management Practices Plan* (WSRC 1991a) and the *Savannah River Site Spill Prevention, Control, and Countermeasures Plan* (WSRC 1991b) are updated as conditions warrant or at least every 3 years. In addition, SRS is obligated under the Federal Facility Agreement (EPA 1993) to identify, evaluate, and, if necessary, remediate spills of hazardous substances, including radionuclides (e.g., high-level liquid radioactive waste leaks). This remediation could include removing, storing, or disposing of contaminated soil. Because SRS has controls to prevent spills, large spills of waste requiring remediation of extensive areas of soil are not expected; therefore, impacts to soils would be very small.

	Min.	Exp.	Max.
No Action			
A			
B			
C			

#### 4.1.3 GROUNDWATER RESOURCES

Facilities and activities that are part of the no-action alternative which could affect groundwater quantity or quality include the M-Area Air Stripper, additional mixed waste storage buildings, intermediate-level, low-activity, and RCRA-permitted waste disposal vaults, long-lived waste storage buildings, shallow land disposal units, transuranic and alpha waste storage pads, and the Defense Waste Processing Facility. Since these facilities do not withdraw groundwater in quantities that

would materially affect the availability of this resource, the focus of these assessments was on their potential to impact groundwater quality.

The M-Area Air Stripper (see Appendix B.14 for description) removes volatile organic compounds from contaminated groundwater beneath A- and M-Areas. Based on current data, DOE anticipates that it would need to operate the M-Area Air Stripper for the remainder of its 30-year post-closure period (1987 to 2017) to meet the groundwater protection standard (40 CFR 264.92) for the contaminants trichloroethylene and tetrachloroethylene. The air stripper would also treat investigation-derived hazardous wastes generated from groundwater monitoring wells. Effects of the continued operation of the M-Area Air Stripper on groundwater quality at SRS would be beneficial because of the continued removal of volatile organic compounds from groundwater beneath A- and M-Areas.

For the remaining storage and disposal facilities, the most important impact to the groundwater resources of SRS is the potential for the leaching of radioactive and hazardous constituents by rainfall infiltration. There is also a potential for groundwater contamination during construction as a consequence of leaks and spills of oil, fuel, or other chemicals from construction equipment. However, the potential impacts of such spills or leaks would be mitigated by using spill prevention plans and best management practices, as described in Section 4.1.2.

DOE would design and construct waste storage facilities and engineered disposal vaults to prevent releases, as described for the individual facility types in Appendix B, and would inspect and monitor them to ensure their continued integrity. Their operation, therefore, is very unlikely to adversely affect groundwater quality during the 30-year period considered in this eis. Releases to groundwater could occur, however, whenever active maintenance is discontinued. For shallow land disposal facilities (i.e., slit trenches), releases could occur sooner. For purposes of assessment, it is assumed that institutional controls, including active maintenance, would be continued for 100 years. The potential impacts of releases from both disposal vaults and slit trenches were evaluated by calculating the effects of infiltration and the leaching of radionuclides from wastes on the concentration of radionuclides in groundwater beneath these facilities at a compliance point defined as a hypothetical well 100 meters (328 feet) away (Toblin 1995). The predicted groundwater concentrations were derived from information provided in the *Radiological Performance Assessment for the E-Area Vaults Disposal Facility* (Martin Marietta, EG&G, and WSRC 1994). The Radiological Performance Assessment evaluated disposal of unstabilized waste forms in the intermediate-level waste vaults, low-activity waste vaults, as well as suspect soil in slit trenches. This evaluation calculated the groundwater concentrations for each nuclide per curie of that nuclide in each of the waste disposal facilities (intermediate-level waste vaults, low-activity waste vaults, and slit trenches). The groundwater concentrations predicted in this environmental impact statement (eis) were derived by applying these Radiological Performance Assessment-determined unit dilution factors to the anticipated inventories in each type of facility for each alternative and waste forecast.

After the draft eis was issued, DOE reevaluated the isotopic inventory of wastes and modified the inventories assumed in this eis to better reflect waste composition. Because curium-247 and -248 are not present at detectable concentrations in the current wastes and are not expected to occur at detectable concentrations in any future waste, these isotopes were removed from the inventories considered in analysis. Therefore, the curium-247 and -248 exceedances discussed in the draft eis do not occur under any alternative.

Thus, the groundwater concentrations were predicted for the alternatives in this eis by scaling from

the Radiological Performance Assessment based on the number and type of facilities required, the radionuclide inventories, and the characteristics of the unstabilized waste forms. Factors such as retardation of radionuclide movement in groundwater by sorption processes, which differ between nuclides, were considered, as were the characteristics of the shallow aquifer (through which migration to surface water would occur). These concentrations were not added to existing groundwater contamination levels since, as noted below, they would not occur until a century or more in the future, after current groundwater concentrations would have been reduced by natural means (decay) or remediation activities. Potential contamination of the deep Middendorf aquifer (formerly known as the Tuscaloosa) was determined in an earlier eis (DOE 1987) not to be a concern because of the isolation of that aquifer from the shallow aquifer affected by these facilities.

The disposal of stabilized waste forms (ashcrete, glass) in slit trenches was not evaluated in the Radiological Performance Assessment and is subject to completion of performance assessments and demonstration of compliance with performance objectives required by DOE Order 5820.2A ("Radioactive Waste Management"). Therefore, DOE was unable to base an analysis of stabilized waste in slit trenches on the Radiological Performance Assessment. The analysis presented in the draft eis did not account for the reduced mobility of stabilized waste forms in slit trenches. The final eis assumes that releases from these wastes in slit trenches would not exceed the performance objectives specified by DOE Order 5820.2A. As a result of the modified assessment approach, exceedances for uranium and plutonium isotopes identified in the draft eis under some alternatives and waste forecasts are no longer predicted to occur. DOE would re-evaluate the performance assessment and, if necessary, adjust either the waste acceptance criteria or the inventory limit for the storage or disposal units to ensure compliance with these criteria, or standards which may become applicable in the future. The results of applying this assessment methodology to the different storage and disposal facilities are presented below.

The performance objectives required by DOE Order 5820.2A include ensuring that groundwater resources are protected as required by federal, state, and local requirements. Additionally, public drinking water standards promulgated in 40 CFR 141 which limit dose to 4 millirem per year were adopted by DOE in Order 5400.5 ("Radiation Protection of the Public and the Environment").

Compliance with the performance objectives required by DOE is determined by comparing the annual dose resulting from drinking 2 liters per day of the contaminated groundwater. This annual dose was compared with the 4 millirem per year effective dose equivalent criterion specified in DOE Order 5400.5. The factors used to convert from groundwater concentrations to dose are specified in DOE Order 5400.5. Assessment of compliance with this dose criterion was based on the potential additive effects of new units contaminating the same groundwater. The concentration values do not, however, include the groundwater contamination from prior waste disposal activities at SRS, as presented in Chapter 3. Groundwater contamination resulting from the waste disposal under this eis would be in addition to existing contamination from past waste disposal. By the time that concentrations resulting from waste disposal activities evaluated in this eis reached their peak (at least 97 to 130 years in the future), the concentrations of contaminants introduced by past disposal will have been substantially reduced below present concentrations as a result of natural decay processes and any environmental restoration programs.

Three types of vaults B RCRA-permitted disposal vaults, intermediate-level waste vaults, and low-activity waste vaults B would be used in E-Area. The existing vaults are subsurface structures designed to comply with the performance objectives of DOE Order 5820.2A. The performance assessment described above considered intact vaults operating as designed and a worst-case scenario

of a fractured protective cap and fractured vaults (Martin Marietta, EG&G, and WSRC 1994). The groundwater analysis (Toblin 1995) determined that during the 30-year period of this eis (1995 through 2024), releases of radionuclides from intermediate-level waste vaults or low-activity waste vaults are not expected to reach the 100-meter (328-foot) compliance point, even conservatively assuming an infiltration rate of 40 centimeters per year. The analysis also assumes that failure and collapse of either type of vault would be expected to occur as a result of normal deterioration within a period ranging from 570 years for the development of cracks in a vault's roof to over 1,000 years for a roof's collapse.

Under normal conditions vaults are slightly permeable, so some easily-leachable constituents will move through them and into the groundwater. The modeling results from this groundwater analysis indicate that tritium would be the first radionuclide detected at the compliance point. Assuming infiltration at a rate of 40 centimeters per year, the peak concentration of tritium in groundwater at the compliance point would occur after 130 years for the intermediate-level waste vaults and after 97 years for the low-activity waste vaults. Peak concentrations of tritium in groundwater from these facilities would be  $7.3 \times 10^{-4}$  and  $1.0 \times 10^{-6}$  picocuries per liter, respectively, which are very small fractions of the 20,000 picocuries per liter limit specified in the EPA drinking water standard for this nuclide, and are not measurable by current instrumentation. In addition, during the 100-year institutional control period, periodic site inspections would discover any visible degradation of the cover and drainage system constructed over the vaults after the vaults are closed, and corrective actions would be taken.

The modeling results of the groundwater analysis for both types of low-level waste vaults beyond the institutional control period predicts that no dose of any constituent placed in these vaults under the no-action alternative would exceed the 4 millirem per year drinking water dose criterion at any time after disposal. The disposal of wastes in the RCRA-permitted vaults was not evaluated quantitatively. It would be subject to completion of performance assessments and demonstration of compliance with the performance objectives required by DOE Order 5820.2A. Therefore, DOE has conservatively assumed that groundwater concentrations as a result of radioactive releases from the RCRA-permitted vaults and all other low-level waste disposal facilities (vaults and slit trenches) would remain within the DOE performance objective of 4 millirem per year adopted by DOE in Order 5400.5.

Releases of nonradioactive constituents from the RCRA-permitted vaults were not evaluated in this eis. Hazardous constituent releases to groundwater could occur as a result of vault failure after loss of institutional control. The hazardous constituents in these vaults would consist primarily of metals, such as mercury and lead. These do not decay over time as do radioactive constituents such as tritium. Potential groundwater concentrations of hazardous constituents have not been evaluated, but some hazardous metals might enter groundwater following degradation of the vaults and waste forms.

Under the no-action alternative, shallow land disposal of radioactive waste would also continue. DOE Order 5820.2A as now implemented requires that performance assessments for radioactive waste management at DOE facilities be conducted prior to disposal of wastes. Recently issued guidance for management of low-level waste at SRS (WSRC 1994a) prohibited shallow land disposal of wastes without a radiological performance assessment after March 31, 1995 (see Appendix B.27). The performance assessment referred to above (Martin Marietta, EG&G, and WSRC 1994) evaluated the impact of shallow land disposal of suspect soils on groundwater quality near the center of SRS (west of the E-Area vaults). Modeling results for suspect soils under the no-action alternative (Toblin 1995) indicate that none of the radionuclides analyzed would exceed the 4 millirem per year drinking water dose criterion at any time. The projected impacts on groundwater resources at SRS from E-Area

disposal facilities do not consider existing groundwater contamination beneath the Burial Ground Complex, because of the time displacements of the impacts, as discussed earlier.

Under the no-action alternative, DOE would store packaged mixed wastes on concrete pads within each of the mixed waste storage buildings; each pad would include a concrete sump to collect and contain leaks per RCRA requirements (see Appendix B.18). Therefore, it is not anticipated that operation of these mixed waste storage buildings through the year 2024 would affect the quality of groundwater in the area. Shallow groundwater in this area flows to Upper Three Runs and Crouch Branch to the north and northeast and to Fourmile Branch to the south. Mixed waste storage buildings would be located a short distance from two of these streams (see Figures 4-1 and 4-2). However, these buildings would be above-grade, zero-release facilities and, as discussed above, releases would not be expected to soils, streams, or groundwater. If, however, releases did occur, groundwater monitoring around such facilities would detect contaminants in groundwater and mitigation by containment, removal, and proper disposal of contaminated media would be implemented.

The no-action alternative also calls for construction of 24 long-lived radioactive waste storage buildings, 19 transuranic and alpha waste storage pads, 26 114-cubic-meter (30,000-gallon) organic waste storage tanks, and 43 114-cubic-meter (30,000-gallon) aqueous waste tanks in E-Area (see Figure 4-2). These storage facilities would be designed and constructed to meet regulatory requirements to protect human health and the environment, including maintenance of zero releases as noted above. The long-lived waste storage buildings and the transuranic and alpha waste storage pads would include sumps to collect and contain leaks. Below-grade organic waste tanks would be constructed with secondary containment and leak detection and leachate collection systems, as required by the Resource Conservation and Recovery Act (RCRA). Neither the low-level waste and transuranic and alpha waste storage facilities nor the above- and below-grade mixed waste tanks are expected to adversely affect the quality of groundwater at SRS under normal circumstances.

Because DOE would not intend to release the areas containing these storage facilities to unrestricted access, the facilities would not be designed to function for extended time intervals without institutional control and maintenance. Accordingly, no assessment of potential releases from long-term unattended operation of these facilities and their contents has been performed.

The Defense Waste Processing Facility and the Z-Area Saltstone Facility would operate under the no-action alternative for this eis. High-level waste stored in the F- and H-Area tank farms would be gradually removed for vitrification, storage and permanent disposal. As the high-level waste is removed from the tanks and vitrified, the potential for inadvertent releases to groundwater would decrease. Possible effects on groundwater would be minimized with the treatment and ultimate disposal of the high-level waste. In case of accidental spills of salt solution (e.g., from transfer pipes in the tank farms) during Defense Waste Processing Facility operations, the soil would be expected to slow the migration of contaminants in the subsurface, and remedial actions would be undertaken to recover as much of the spilled material as is feasible and to minimize the dispersal of the residual material. The effects on groundwater of the operation of the Defense Waste Processing Facility and the Saltstone Facility were presented in the *Final Supplemental Environmental Impact Statement Defense Waste Processing Facility*

	Min.	Exp.	Max.
No Action			
A			
B			
C			

#### 4.1.4 SURFACE WATER RESOURCES

This section examines the no-action alternative activities (described in Section 2.2) that would produce wastewater discharges to surface waters and presents the potential effects on the environment from both radiological and nonradiological constituents contained in treated wastewater. The evaluation of these consequences is based on Section 4.1.3. Evaluation of these consequences assumed that existing regulatory limits would continue to apply for the various nonradiological constituents. The radiological criterion used as the basis for this evaluation comply with DOE Order 5400.5 and 40 CFR 141, the U.S. Environmental Protection Agency (EPA) national primary drinking water regulations.

Spills or leaks could occur from various tanks and equipment. Sumps and secondary containment around tanks and vulnerable equipment would capture and collect spills or leaks if they were to occur. Material that accumulates in sumps and secondary containment would be sampled to determine if contaminants were present. If contaminated, the wastewater would be treated in the appropriate treatment facility, such as the F/H-Area Effluent Treatment Facility or the M-Area Dilute Effluent Treatment Facility. Uncontaminated wastewater would be discharged via a permitted outfall to surface waters. SRS has and would maintain a best management practices plan, a spill prevention control and countermeasures plan, and administrative procedures for monitoring and cleaning up spills to prevent them from reaching a surface stream.

In construction of the various storage facilities needed under the no-action alternative in E-Area, DOE would prepare sedimentation and erosion control plans in compliance with state regulations on stormwater discharges, which became effective in 1992 as part of the Clean Water Act. SRS was issued a permit by SCDHEC (Permit SCR100000) that applies to stormwater runoff during construction activities. If a project requires disturbing more than 0.02 square kilometer (5 acres) of land, SCDHEC must approve the sediment and erosion control plan. Facilities or measures taken to control erosion during the construction phase would be regularly inspected by SCDHEC; the Management and Operating Contractor's Environmental Protection Department; the U.S. Natural Resources Conservation Service (formerly the Soil Conservation Service); and the U.S. Forest Service to monitor the effectiveness of the erosion control measures (particularly following a storm). Corrective measures, if needed, would be taken by DOE. After facilities begin operating, they would be included in the *SRS Stormwater Pollution Prevention Plan*, which details the required stormwater control measures and is one of the criteria of the stormwater general permit issued to SRS by SCDHEC (Permit SCR000000) for operating facilities. Also, as required by the National Pollutant Discharge Elimination System permit, the facilities would be included in the *SRS Best Management Practices Plan*.

Studies have been performed to determine the effect of stormwater that might infiltrate waste in the disposal facilities in E-Area and then enter the groundwater. As noted in Section 4.1.3, the incremental increase in groundwater concentrations of the radionuclides present in the waste would

be small. Most of the radionuclides would not reach peak concentrations in the river until at least 10,000 years beyond the present. The tritium would peak in 70 to 237 years at a concentration below 10-5 picocuries per liter, which is one billion times below the regulatory limits; iodine-129, selenium-79 and technetium-99 would peak in 150 to 9,700 years at concentrations below 10-6, 10-6, and 10-4 picocuries per liter, respectively, which are also well below regulatory limits (Toblin 1995). Thus, the impact on the Savannah River from groundwater which reaches the surface and eventually enters the river would be very small.

The M-Area Vendor Treatment Facility (see Appendix B.15) would not discharge wastewater directly to a surface stream. However, the wastewater discharged from the scrubber system [an average flow of approximately 0.5 liter (0.13 gallon) per minute] would be directed to the M-Area Dilute Effluent Treatment Facility (DOE 1993a), which can adjust the wastewater pH, add alum as a coagulant, settle the resulting suspended solids, and dewater the solids. Since the wastewater from the scrubber system would be similar in composition to the wastewater already being treated, the surface water would receive little, if any, impact from the discharge of this additional treated water. The water resources section in Appendix E lists the minimum and maximum chemical concentrations found in the effluent from the M-Area Liquid Effluent Treatment Facility, which includes the Dilute Effluent Treatment Facility (outfall M-004). The treatment facility has been meeting the discharge criteria. The M-Area Liquid Effluent Treatment Facility has been processing approximately 53 liters (14 gallons) per minute for the last several years (Arnett 1994), but it is designed to treat 100 liters (26 gallons) per minute. Thus, the additional flow of 0.5 liter (0.13 gallon) per minute from the M-Area Vendor Treatment Facility would have a very small effect on the flow rate of the water being treated and the effectiveness of the treatment facility. The treated water would be discharged to Tims Branch via National Pollutant Discharge Elimination System permitted outfall M-004. A DOE environmental assessment (DOE 1993a) concluded that water quality and indigenous biota within the receiving stream (Tims Branch) would not be adversely impacted by this discharge of treated water.

Additional wastewater streams would be treated in existing SRS wastewater treatment facilities. The M-Area Air Stripper removes volatile organic compounds from the groundwater beneath A- and M-Areas. The air stripper is permitted by SCDHEC to treat 2,270 liters (600 gallons) per minute of contaminated groundwater and operates at approximately 1,900 liters (500 gallons) per minute. Purge water containing volatile organic compounds from the monitoring wells would be treated by the air stripper. An additional 2 liters (0.53 gallon) per minute average flow of purge water would be treated by the air stripper. The operation of the air stripper would not be compromised, and the quality of the effluent would not change.

Additional wastewater would be sent to the F/H-Area Effluent Treatment Facility, either directly or after being treated in one of the high-level waste evaporator systems. The F/H-Area Effluent Treatment Facility has a design flow rate of 1,135 liters (300 gallons) per minute. The projected additional wastewater stream for the no-action alternative (based on the expected waste forecast) is estimated to be 1.8 liters (0.48 gallon) per minute. There would also be 26 liters (6.9 gallons) per minute of recycle water from the Defense Waste Processing Facility being sent to the F/H-Area Effluent Treatment Facility. Thus, the additional flow of wastewater to be treated would be 27.8 liters (7.3 gallons) per minute. Since the facility processes approximately 114 liters (30 gallons) per minute, this additional flow would be within its design capability. The *Final Supplemental Environmental Impact Statement Defense Waste Processing Facility* discusses the effects of this wastewater on the treatment processes. This release, on an annual basis, represents approximately 15 percent of the total dose to the offsite maximally exposed individual from liquid releases from SRS in 1993. The water resources section in Appendix E lists the minimum and maximum chemical concentrations which

were reported for the F/H-Area Effluent Treatment Facility outfall (outfall H-016) for 1993. The effluent concentrations have been in compliance with the permit limits. Since the additional wastewater is of similar composition to the wastewater already being treated by this system, the quality of the effluent from the F/H-Area Effluent Treatment Facility is not likely to change. The calculated dose of the various radionuclides is included in the tables in Appendix E. Two radionuclides account for more than 99 percent of the calculated dose: tritium and cesium-137 together account for 0.0206 millirem of the total dose of 0.0208 millirem to the offsite maximally exposed individual over the 30-year period (1995 through 2024). The impact on Upper Three Runs from radionuclides would be very small.

The Replacement High-Level Waste Evaporator would eventually replace existing evaporators and would produce distillate of the same quality as produced by the present evaporators and which would be treated in the F/H-Area Effluent Treatment Facility. Concentrated waste from the evaporator would be sent to the Defense Waste Processing Facility (WSRC 1994b). Operation of the replacement evaporator would not change the quality of the wastewater discharges. The wastewater flow would be approximately the same because the older evaporators would be retired.

	Min.	Exp.	Max.
No Action			
A			
B			
C			

#### 4.1.5 AIR RESOURCES

The no-action alternative would result in additional nonradiological and radiological emissions from SRS. In both cases, the resulting incremental increase in air concentrations at and beyond the SRS boundary would be very small compared to existing concentrations at and beyond the SRS boundary. Operations under the no-action alternative would not exceed state or Federal air quality standards.

##### 4.1.5.1 Construction

Potential impacts to air quality from construction activities under the no-action alternative would include fugitive dust and emissions from construction equipment. Fugitive dust results from soil transportation activities, moving and maintenance of soil piles, and clearing and excavation of soil. Approximately 182,500 cubic meters (239,000 cubic yards) of soil would be displaced in E-Area for the construction of the treatment, storage, and disposal facilities listed in Section 2.2.7.

The amount of fugitive dust produced was assumed to be proportional to the land area disturbed. Amounts of fugitive dust for the no-action alternative were calculated from the estimated annual average amount of soil excavated during construction activities over the 30-year analysis period. Fugitive soil emissions are based on U.S. Environmental Protection Agency (EPA) AP-42 emission factors and the number of cubic meters of soil excavated (EPA 1985; Hess 1994a). Maximum downwind concentrations at the SRS boundary for total suspended particulates and particulate matter less than 10 microns in diameter were calculated using EPA's TSCREEN model (EPA 1988).

Exhaust emissions from construction equipment were calculated from estimates of the types and number of earth-moving equipment required and from EPA AP-42 emission factors. Maximum downwind concentrations for criteria pollutants at the SRS boundary were calculated using EPA's TSCREEN model (EPA 1988).

The 30-year average annual concentrations due to construction activities are shown in Table 4-1. The increases in SRS-boundary concentrations due to construction activities would be less than state and Federal ambient air quality standards for all air contaminants.

**Table 4-1. Average increase over baseline of criteria pollutants at the SRS boundary from construction-related activities under the no-action alternative.**

Pollutant	Averaging time	No-action alternative		SCDHEC standard <sup>e</sup> (mg/m <sup>3</sup> )	Existing + increase as percent of standard (% <sup>f</sup> )
		Baseline (mg/m <sup>3</sup> ) b,c	Increased (mg/m <sup>3</sup> )		
Nitrogen oxides	1 year	14	0.01	100	14
Sulfur dioxide	3 hours	857	65.65	1,300	71
	24 hours	213	1.27	365	59
	1 year	17	<0.01g	80	21
Carbon monoxide	1 hour	171	1,919	40,000	5
	8 hours	22	302	10,000	3
Total suspended particulates	1 year	43	0.01	75	57
Particulate matter less than 10 microns in diameter	24 hours	85	5.24	150	60
	1 year	25	0.01	50	50

a. Baseline includes background concentrations and the contributions from existing sources.

b. Micrograms per cubic meter.

c. Source: Stewart (1994).

d. Source: Hess (1994a).

e. Source SCDHEC (1976).

f. Percent of standard = 100 \* (existing sources + baseline + increase) divided by regulatory standard.

g. < is read as "less than."

#### 4.1.5.2 Operations

The following facilities were included in the no-action alternative air dispersion modeling analysis: the Defense Waste Processing Facility, including In-Tank Precipitation; additional organic waste

storage tanks; the M-Area Vendor Treatment Facility; additional mixed waste storage tanks (E-Area); and hazardous and mixed waste storage facilities.

Air emissions from disposal vaults in E-Area are very small because solvents and solvent-contaminated rags are not disposed of in the vaults. Solvents and solvent-contaminated rags are stored in drums, with pressure relief valves that release with pressures greater than 280 grams per square centimeter (4 pounds per square inch), located in the hazardous waste and mixed waste storage buildings. Emissions are very small under routine operating conditions because pressure changes greater than 280 grams per square centimeter (4 pounds per square inch) would occur only during emergency conditions, such as a fire.

To determine which facility source terms should be revised to accurately reflect the structure of operations of the no-action alternative, a thorough review of facilities was performed. The following summarizes facility source terms that were not changed and the rationale for not modifying them.

Changes in impacts to maximum boundary-line concentrations would not be expected to result from the continued operation of the F- and H-Area evaporators, the F/H-Area Effluent Treatment Facility, the lead melter, solvent reclamation units, the silver recovery unit, the Organic Waste Storage Tank, Savannah River Technology Center ion exchange process, the low-level waste compactors, or the M-Area Air Stripper, because these facilities are currently operating. Additional organic emissions from the M-Area Air Stripper due to the treatment of investigation-derived waste from groundwater monitoring well operations would be less than 13 kilograms (29 pounds) per year; the incremental contribution to maximum boundary-line concentrations would be very small [less than 0.005 micrograms per cubic meter, based on TSCREEN modeling and Hess (1995a)]. Additional organic emissions from the F/H-Area Effluent Treatment Facility would be 2.7 kilograms (6 pounds) per year; the incremental impact would be very small (Hess 1994b).

#### **4.1.5.2.1 Nonradiological Air Emissions Impacts**

Table 4-2 shows maximum ground-level concentrations at the SRS boundary for nonradiological air pollutants emitted under the no-action alternative. Air dispersion modeling was performed with calculated emission rates for facilities not yet operating and actual 1990 emission levels for facilities currently operating (Stewart 1994). For proposed facilities for which permit limits have not yet been established, emissions were estimated based on operational processes (see Appendix B) and data obtained from similar activities at SRS and other waste management facilities. The dispersion calculations for criteria pollutants were performed with 1991 meteorological data from H-Area. DOE used periods ranging from 1 hour to 1 year to model criteria pollutant concentrations, which correspond to the averaging periods found in South Carolina's "Ambient Air Quality Standards" (SCDHEC 1976).

Maximum ground-level concentrations for nonradiological air pollutants were determined from the Industrial Source Complex Version 2 Dispersion Model using maximum potential emissions from all the facilities proposed in the no-action alternative (Stewart 1994). The calculations for the dispersion of carcinogenic toxic substances were performed with 1991 meteorological data from H-Area. Modeled air toxic concentrations for carcinogens were based on an annual averaging period and are presented in Section 4.1.12.2.2. To get a 30-year exposure period, annual averages were calculated by adding all emissions occurring in an annual period, and then proportioning the emissions on a unit-

time basis (e.g., grams per second). Under the no-action alternative, emissions of noncarcinogenic air toxics are very small. Maximum boundary-line concentrations for all SCDHEC air toxics are very small and are below SCDHEC regulatory standards. They are presented in the *SCDHEC Regulation No. 62.5 Standard No. 2 and Standard No. 8 Compliance Modeling Report Input/Output Data* (WSRC 1993b) and in Section 3.5 of this eis.

**Table 4-2. Changes in maximum ground-level concentrations of criteria pollutants at the SRS boundary from operation activities under the no-action alternative.**

Pollutant	Averaging time	Existing sources ( $\mu/m^3$ ) a,b	Regulatory standards ( $\mu/m^3$ ) c	Background concentration ( $\mu/m^3$ ) d	Increase in concentration ( $\mu/m^3$ )	Existing + background + increase as percent of standard (%) e
Nitrogen oxides	1 year	6	100	8	0.11	14f
Sulfur dioxide	3 hour	823	1300	34	15.36	67
	24 hour	196	365	17	2.8	59
	1 year	14	80	3	0.08	21
Carbon monoxide	1 hour	171	40,000	NAg	24.2	0.5
	8 hour	22	10,000	NA	4.03	0.3
Total suspended particulates	1 year	13	75	30	2.02	60
Particulate matter < 10 microns in diameter	24 hour	51	150	34	5.20	60
	1 year	3	50	22	0.13	50
Lead	3 months	4'10 <sup>-4</sup>	1.5	0.011	0	0.8
Gaseous fluorides (as hydrogen fluoride)	12 hour	2	3.7	NA	0.0019	54
	24 hour	1	2.9	NA	9'10 <sup>-4</sup>	35
	1 week	0.4	1.6	NA	3.5'10 <sup>-4</sup>	25
	1 month	0.1	0.8	NA	9'10 <sup>-5</sup>	13

a. Micrograms per cubic meter.

b. Source: Stewart (1994).

c. Source: SCDHEC (1976).

d. Source: SCDHEC (1992).

e. Percent of standard = 100 \* (existing sources + background + increase in concentration) divided by regulatory standard.

f. For example, 6 + 8 + 0.11 divided by 100 would equal 14.11 percent, rounded to the nearest whole number, 14 percent.

g. NA = not applicable.

#### 4.1.5.2.2 Radiological Air Emissions Impacts

Offsite maximally exposed individual and population doses are presented for atmospheric releases resulting from routine operations under the no-action alternative. The largest sources of radionuclides would be from activities at the transuranic and alpha waste storage pads, the F- and H-Area tank farms, M-Area Vendor Treatment Facility, and the F/H-Area Effluent Treatment Facility.

SRS-specific computer models MAXIGASP and POPGASP (Hamby 1992) were used to determine the maximum individual dose at the SRS boundary and the 80-kilometer (50-mile) population dose, respectively, resulting from routine atmospheric releases. See Appendix E for detailed facility-specific isotopic and dose data.

Table 4-3 shows the doses to the offsite maximally exposed individual and the population as a consequence of the normal radiological emissions from the no-action alternative activities. The calculated incremental committed effective annual dose equivalent to the hypothetical offsite maximally exposed individual would be  $1.2 \times 10^{-4}$  millirem [doses were calculated using dose factors provided by Simpkins (1994a)], which is well within the annual dose limit of 10 millirem for SRS atmospheric releases. In comparison, an individual living near SRS receives a dose of 0.25 millirem from all current releases of radioactivity at SRS (Arnett 1994).

The annual incremental dose to the population within 80 kilometers (50 miles) of SRS from the no-action alternative would be  $2.9 \times 10^{-4}$  person-rem. In comparison, the collective dose received from natural sources of radiation is approximately  $1.95 \times 10^5$  person-rem (Arnett, Karapatakis, Mamatey 1994). Sections 4.1.12.1 and 4.1.12.2 describe the potential health effects of these releases on the workers and public, respectively.

	Min.	Exp.	Max.
No Action			
A			
B			
C			

**Table 4-3. Annual radiological doses to individuals and the population within 80 kilometers (50 miles) of SRS from atmospheric releases under the no-action alternative.a**

Offsite maximally exposed individual		Population
Release Pathway	Dose (millirem)	Dose (person-rem)
Atmospheric	$1.2 \times 10^{-4}$	$2.9 \times 10^{-4}$

a. Source: Simpkins (1994a).

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#### 4.1.6 ECOLOGICAL RESOURCES

Under the no-action alternative, disturbed areas would be cleared and graded to build new waste storage and disposal facilities. (Areas are given in acres; to convert to square kilometers, multiply by 0.004047.) Approximately 160 acres of the following types of woodlands would be cleared and graded by 2024:

- 7 acres of slash pine planted in 1959
- 42 acres of loblolly pine planted in 1987
- 26 acres of white oak, red oak, and hickory regenerated in 1922
- 44 acres of longleaf pine planted in 1922, 1931, or 1936
- 3 acres of loblolly pine planted in 1946
- 20 acres of longleaf pine planted in 1988
- 18 acres from which mixed pine/hardwood was recently harvested

Larger, more mobile animal species inhabiting the undeveloped portions of the site, such as fox, raccoon, bobcat, gray squirrel, and white-tailed deer would be able to avoid the clearing and grading equipment and escape; smaller, less mobile species such as reptiles, amphibians, and small mammals could be killed or displaced by the logging and earth-moving equipment. Although the animals displaced by construction will likely survive for some time in newly established home ranges, these individuals or those whose home ranges they infringe on may die or experience decreased reproduction. The net result of the construction would be less habitat and therefore fewer individuals. If the clearing were done in the spring and summer, birds' nests, including nestlings and eggs, would be destroyed. Hardwood-dominated sites on steep slopes and in wetlands would be avoided whenever possible. Approximately 15 percent of the total acreage of mature hardwoods in or near E-Area would be cleared (Figure 3-9). The clearing of hardwoods would be restricted to some upland areas required for sediment ponds (Figures 3-9 and 4-2).

Construction and operation of storage and disposal facilities within the previously cleared and graded portions of E-Area would have little effect on terrestrial wildlife. Wildlife habitat in these areas is poor and characterized by mowed grassy areas with few animals. Birds and mammals that use these areas, mostly for feeding, would be displaced by construction activities, but it is unlikely that they would be physically harmed or killed.

The undeveloped land between the M-Line railroad and the E-Area expansion and extending northwest of F-Area is described in Section 3.6. Animal species common to these areas are typical of the mixed pine/hardwood forests of South Carolina and are described in Section 3.6.1.

Wetlands would not be affected by construction on the developed or undeveloped lands (Ebasco 1992). Potential adverse effects to the downstream wetlands, aquatic macroinvertebrate, and fish species of Crouch Branch and five small unnamed tributaries to Upper Three Runs would be minimized during construction by installing sediment and erosion control devices before clearing begins, maintaining the sediment and erosion control devices, properly grading the slopes, and stabilizing the site. By state law, construction activities on SRS must have an approved sediment and

erosion control plan (see Section 4.1.2). Proper construction and maintenance of sediment ponds and stormwater basins would mitigate adverse effects to the wetlands during operation of waste storage and disposal facilities. Additional sediments are not likely to reach the wetlands adjacent to Upper Three Runs.

The effect of additional wastewater discharges to surface waters for the no-action alternative are presented in Section 4.1.4. Small changes would occur to discharge rates, but the wastewater discharges would remain within permit limits. The aquatic biota in the receiving streams would not be affected because the water quality would not change.

Suitable habitat for the red-cockaded woodpecker exists in the area adjacent to E-Area. Red-cockaded woodpeckers prefer to nest in living pine trees over 70 years of age and forage in pine stands over 30 years of age (Wike et al. 1994). Trees suitable for nesting and foraging are found throughout SRS. In 1986, DOE and the U.S. Fish and Wildlife Service agreed on a red-cockaded woodpecker management plan at SRS, which is based on dividing SRS into two management areas (Henry 1986) (Figure 4-3).

One management area (112,000 acres; Management Area Two) forms a natural buffer just within the SRS boundary. This management area contains most of the suitable red-cockaded woodpecker habitat on SRS and all the active colonies. Timber in this area is managed to produce a viable population of red-cockaded woodpeckers. The red-cockaded woodpecker population has increased from 5 in 1985 to 77 in 1994 (LeMaster 1994a).

The other management area (69,000 acres; Management Area One; Figure 4-3) includes developed areas of SRS and adjacent woodland. E-Area and the area of proposed expansion are located within this management area. While potential red-cockaded woodpecker habitat occurs within this area, no active colonies or birds have been identified. By agreement between DOE and the U.S. Fish and Wildlife Service, Management Area Two, the outer ring of the SRS, has been dedicated to enhancement of SRS natural resource management areas, Savannah River Swamp, Lower Three Runs corridor, and research set-aside areas. red-cockaded woodpecker populations and habitat, and reserved for timber management activities compatible with this goal. In the same agreement, Management Area One, the central core of SRS that includes E-Area, has been dedicated to DOE mission requirements and intensive timber management. The area northwest of F-Area contains suitable nesting and foraging habitat. This area was surveyed for red-cockaded woodpeckers in 1993 and no colonies or foraging birds were located (LeMaster 1994a). Because of the intensive red-cockaded woodpecker management conducted on most of SRS, clearing of this land would not affect red-cockaded woodpeckers.

### **Figure 4-3.**

The smooth coneflower is another Federally protected species on SRS. It grows in open woods, in cedar barrens, along roadsides, in clearcuts, and in powerline rights-of-way B habitat which is available in the area. However, the species was not found in or near E-Area during 1992 or 1994 botanical surveys (LeMaster 1994b).

One Federally listed Category 2 species, the American sandburrowing mayfly, is known to occur in Upper Three Runs. Several Federally listed Category 2 animal species could occur on the site proposed for new construction. These species include the southern hognose snake, northern pine snake, loggerhead shrike, and Bachman's sparrow.

Botanical surveys performed during 1992 and 1994 by the Savannah River Forest Station located four populations of rare plants in or adjacent to E-Area (see Figure 4-4). One population of *Nestronia umbellula* (a shrub) and three populations of Oconee azalea (*Rhododendron flammeum*) were located on the steep slopes adjacent to the Upper Three Runs floodplain (LeMaster 1994b). The Oconee azalea is a South Carolina-listed rare species. *Nestronia umbellula* was a Federally listed Category 2 species that was found to be more abundant than previously believed; consequently, it is no longer listed (USFWS 1993). These species would not be adversely impacted by the no-action alternative.

DOE prepared a Protected Species Survey (April 1995) based on information presented in the draft eis and submitted it to the U.S. Fish and Wildlife Service and the National Marine Fisheries Service as part of the formal consultation process in compliance with the Endangered Species Act of 1973. The survey is included as Appendix J of this eis. Both the U.S. Fish and Wildlife Service and the National Marine Fisheries Service concur with DOE's determination of no jeopardy (i.e., no impact to endangered species) for the proposed project in the no-jeopardy opinions contained in Appendix J. However, both agencies stated that additional consultation would be necessary as siting for new facilities proceeds. DOE has committed to conduct additional protected species surveys as needed, and to consult with these agencies should changes occur in the proposed project and as new waste management facilities are planned.

**Figure 4-4. Rare plants located near E-Area during Savannah River Forest Station 1992 and 1994 botanical surveys.**

	Min.	Exp.	Max.
No Action			
A			
B			
C			

#### 4.1.7 LAND USE

Land use impacts were evaluated on the basis of the amount of land that would be cleared to build facilities that otherwise would be available for non-industrial uses such as natural resource conservation or research, or future, but unidentified, land options.

DOE would use approximately 0.98 square kilometer (160 acres of undeveloped; 81 acres of developed) of land in E-Area for activities associated with the no-action alternative. SRS has about 181,000 acres of undeveloped land, which includes wetlands and other areas that cannot be developed, and 17,000 acres of developed land.

Activities associated with the no-action alternative would not affect current SRS land-use plans; E-Area was designed as an area for nuclear facilities in the *Draft 1994 Land-Use Baseline Report* (WSRC 1994c). Furthermore, no part of E-Area has been identified as a potential site for future new missions. According to the *FY 1994 Draft Site Development Plan* (DOE 1994a), proposed future land management plans specify that E-Area be characterized and remediated for environmental contamination in its entirety, if necessary. Decisions on future SRS land uses will be made by DOE through the site development, land-use, and future-use planning processes, including public input through avenues such as the Citizens Advisory Board as required by DOE Order 4320.1B.

	Min.	Exp.	Max.
No Action			
A			
B			
C			

#### 4.1.8 SOCIOECONOMICS

This section describes the potential effects of the no-action alternative on the socioeconomic resources in the region of influence. This assessment is based on the estimated construction and operations personnel required to implement this alternative (Table 4-4). Impacts to socioeconomic resources can be evaluated by examining the potential effects from both the construction and operation of each waste management alternative on factors such as employment, income, population, and community resources in the region of influence.

**Table 4-4. Estimated construction and operations employment under the no-action alternative.a**

Year	Construction employment	Operations employment
1995	30	1,880
1996	50	1,880
1997	50	2,000
1998	40	2,210
1999	40	2,310
2000	40	2,420
2001	40	2,420
2002	40	2,420
2003	40	2,450
2004	40	2,450
2005	40	2,450
2006	40	2,450
2007	40	2,450
2008	40	2,450
2009	40	2,450

2010	40	2,450
2011	40	2,450
2012	40	2,450
2013	40	2,450
2014	40	2,450
2015	40	2,450
2016	40	2,450
2017	40	2,450
2018	40	2,450
2019	40	2,450
2020	40	2,450
2021	40	2,450
2022	40	2,450
2023	40	2,450
2024	40	2,450

a. Source: Hess (1995a, b).

#### 4.1.8.1 Construction

Construction employment associated with the no-action alternative is expected to peak in 1996 and 1997 with approximately 50 jobs (Table 4-4). Given the normal fluctuation of employment in the construction industry, DOE does not expect a net change in regional construction employment from implementation of the no-action alternative. Therefore, DOE does not expect socioeconomic resources in the region to be affected.

#### 4.1.8.2 Operations

Operations employment associated with implementation of the no-action alternative would peak during 2003 through 2024 with an estimated 2,450 jobs (Table 4-4), which represents approximately 12 percent of the 1992 SRS employment. DOE expects that these jobs would be filled through the reassignment of existing workers. Thus, DOE anticipates that socioeconomic resources would not be affected by changes in operations employment.

	Min.	Exp.	Max.
No Action			
A			
B			
C			

#### 4.1.9 CULTURAL RESOURCES

Potential impacts on cultural resources can be evaluated by identifying the known or expected important resources in the areas of potential impact and activities that could directly or indirectly affect those significant resources. Potential impacts would vary by alternative relative to the amount of land disturbed for construction, modification, and/or operation of waste management facilities. No areas of religious importance to Native American tribes have been identified within areas to be disturbed by construction and operation of facilities associated with the no-action alternative. While several tribes have indicated general concerns about SRS (see Section 3.9.2), no tribe has specifically identified SRS or specific portions of SRS as possessing religious importance.

A Programmatic Memorandum of Agreement between the DOE Savannah River Operations Office, the South Carolina State Historic Preservation Office, and the Advisory Council on Historic Preservation (SRARP 1989), which was ratified on August 24, 1990, is the instrument for the management of cultural resources at SRS. DOE uses this memorandum to identify cultural resources, assess them in terms of eligibility for the National Register of Historic Places, and develop mitigation plans for affected resources in consultation with the State Historic Preservation Officer. DOE will comply with the terms of the memorandum for activities required to support waste management activities.

Construction within the developed and fenced portion of E-Area would not affect archaeological resources because this area has been disturbed. Most of the construction activities that would take place to the north of the currently developed portion of E-Area would be within an area that was surveyed in 1986 as a potential site for waste disposal facilities (Figure 4-5) (Brooks, Hanson, and Brooks 1986). No important cultural resources were discovered during that survey, and further archaeological work would not be required prior to construction in this area.

As shown in Figure 4-5, there are two small areas of unsurveyed land to the east and northeast of the currently developed portion of E-Area that would be used to support the no-action alternative. In compliance with the Programmatic Memorandum of Agreement (SRARP 1989), DOE would survey these areas before beginning construction. If important resources were discovered, DOE would avoid them or remove them.

The Savannah River Archaeological Research Program has recently completed an archaeological survey of a 4-square-kilometer (1,000-acre) parcel of undeveloped land within E-Area to the north and northwest of F-Area (Figure 4-5). During this survey, 33 archaeological sites were identified, 12 of which may be eligible for listing on the National Register of Historic Places. However, recommendations on eligibility made by the Savannah River Archaeological Research Program are not binding until the South Carolina State Historic Preservation Officer concurs with the recommendations. DOE expects to receive concurrence in 1995. One of the 12 sites that may be eligible for listing on the National Register of Historic Places would be disturbed by construction of a

sediment pond. Some potential exists that other important archaeological sites in the vicinity of new waste management facilities could be indirectly affected if the introduction of contamination were to make the area unsuitable for additional research activities or if operation of the new facilities were to bring a larger permanent workforce closer to the sites. Before beginning construction in this area, the Savannah River Archaeological Research Program and DOE would complete the consultation process with the State Historic Preservation Officer and develop mitigation action plans to ensure that important archaeological resources would be protected and preserved (Sassaman 1994).

**Figure 4-5. Location of previous archaeological survey areas and significant archaeological sites in E-Area.**

	Min.	Exp.	Max.
No Action			
A			
B			
C			

#### 4.1.10 AESTHETICS AND SCIENCE RESOURCES

Impacts were evaluated on the basis of visibility of new facilities from offsite. Under the no-action alternative, the facilities DOE plans to construct in E-Area would not adversely affect scenic resources or aesthetics. E-Area is already dedicated to industrial use. New construction would not be visible off SRS or from public access roads on SRS. The new facilities would not produce emissions to the atmosphere that would be visible or that would indirectly reduce visibility.

	Min.	Exp.	Max.
No Action			
A			
B			
C			

#### 4.1.11 TRAFFIC AND TRANSPORTATION

DOE analyzed impacts under each alternative that would result from changes in daily commuter and truck traffic. Traffic impacts are expressed as increases in vehicles per hour and in the number of hazardous and radioactive waste shipments by truck. As a road's carrying capacity is approached, the likelihood of traffic accidents increases. Similarly, the more truck shipments on a given road, the greater the probability of a traffic accident involving a truck. Increases in either condition could cause an increase in traffic fatalities.

DOE also evaluated the impacts that transportation of low-level, mixed, transuranic, and hazardous wastes would have on individuals located onsite and offsite. These impacts were determined by the calculation of dose and expressed as health effects (i.e., the number of excess fatal cancers resulting from exposure to radioactive waste shipments). High-level waste was excluded from the analyses because it is not transported by vehicle.

Impacts from incident-free (normal) transport and postulated transportation accidents involving onsite

shipment of radioactive waste over 30 years were calculated for the no-action alternative. Offsite transportation impacts were also calculated. The only traffic increases considered were from construction workers traveling to and from the site.

#### 4.1.11.1 Traffic

Vehicle counts were estimated from current and projected levels of SRS employment (Turner 1994) and waste shipments. The baseline number of vehicles per hour was estimated from values in Smith (1989) and Swygart (1994). Table 4-5 shows estimated peak vehicles per hour for representative onsite and offsite roads. The table also shows the design carrying capacity for the roads (vehicles per hour) and the percentage of this design carrying capacity that the expected traffic represents. Vehicles per hour on offsite roads represent daily maximum values, while vehicles per hour onsite represent peak morning traffic. For the no-action alternative, the year when the most people would be employed was used to determine the change from the baseline. These traffic analyses conservatively assume that each worker drives a vehicle and arrives at E-Area during the peak commuter traffic hour.

For the no-action alternative, the roads' carrying capacities would not be exceeded by the workforce increase of 47 vehicles per hour. DOE would not expect adverse impacts from traffic associated with the no-action alternative.

Impacts of daily truck traffic associated with onsite shipments of hazardous and radioactive waste were analyzed for the no-action alternative. These shipments, presented in Table 4-6, are assumed to occur during normal working hours (versus commuter hours), and therefore, would have very little effect on the roadway carrying capacity. Hazardous waste shipments include shipments from accumulation areas to the RCRA-permitted storage buildings and from the storage buildings to offsite treatment and disposal facilities. Shipments of radioactive waste include those from the generators to the treatment, storage, or disposal facilities.

Under the no-action alternative, daily truck shipments would be the same as for the baseline. This assumption was based on transportation data (Hess 1994c) developed from historical shipping configurations for each waste. Baseline waste volumes were estimated from the 30-year expected waste forecast. DOE expects that impacts from waste shipments under the no-action alternative would be the same as for baseline waste management activities. Numbers of shipments assumed under the no-action alternative are given in Tables E.3-1 through E.3-3.

In 1992, South Carolina had a highway fatality rate of 2.3 per 100 million miles driven (SCDOT 1992). At this rate, an estimated 5.5 fatalities would be expected to occur annually within the commuter population for the baseline case based on a 40-mile round-trip commute 250 times a year (see Section 3.11.2.1). For the no-action alternative, an additional 47 workers would be expected to drive an additional one-half million miles per year, which is predicted to result in less than one additional traffic fatality.

The occurrence of highway injuries and prompt fatalities for truck accidents can be estimated from data reported by the National Highway Safety Council (DOT 1982). Injuries occur in 24 percent of all single truck accidents. The estimated injury- and fatality-causing accident rates are  $3.2 \times 10^{-7}$  and  $1.2 \times 10^{-7}$  per mile traveled, respectively.

Trucks carrying hazardous waste have an accident rate of  $1.4 \times 10^{-6}$  accidents per mile traveled for all road types. An estimated 20 percent of these truck accidents will result in a release of hazardous materials (EPA 1984).

Based on these statistics, an analysis (Rollins 1995) was performed to determine impacts from shipments of hazardous and radioactive materials for the 30-year period of interest for this eis. For the no-action alternative, 7,200 annual (onsite and offsite) hazardous and radioactive waste shipments would travel approximately 600,000 miles and would result in slightly less than 1 accident with 0.074 prompt fatality. Accidents involving the release of hazardous material would be expected to occur, on average, once in 6 years.

The analysis determined that the largest impacts would occur for alternative B – maximum waste forecast. For this case, 22,000 annual (onsite and offsite) hazardous and radioactive waste shipments would travel approximately 1.9 million miles, leading to an expectation of less than 3 accidents with 0.23 prompt fatality. Accidents involving the release of hazardous material would be expected to occur, on average, once in 4 years. Impacts for all other alternatives and waste forecasts would be lower. These impacts are considered very small and are not discussed further in this eis.

**Table 4-5. Number of vehicles per hour during peak hours under the no-action alternative.**

Road	Design capacity (vehicles per hour)	1994 baseline traffic (percentage of design capacity) <sup>b</sup>	No-action alternative change (percentage of design capacity) <sup>c</sup>
Offsite			
SC 19	3,000 <sup>d</sup>	2,800 <sup>d</sup> (93)	21(94)
SC 125	3,200 <sup>d</sup>	2,700 <sup>d</sup> (84)	20(85)
SC 57	2,100 <sup>d</sup>	700 <sup>e</sup> (33)	6(34)
Onsite			
Road E at E-Area	2,300 <sup>e</sup>	741 <sup>f,g</sup> (32)	47 <sup>h</sup> (34)

a. Vehicles per hour baseline traffic for 1994 was estimated from actual counts measured in 1989 (offsite) and 1992/1993 (onsite) (Smith 1989) by adjusting vehicle counts by the change in SRS employment between measured years and 1994.

b. Numbers in parentheses indicate percentage of carrying capacity.

c. Percentage of design capacity changed between the draft and final eis because the manpower numbers are based on construction costs which were modified after the draft was issued to better reflect actual costs.

d. Adapted from Smith (1989).

- e. Adapted from TRB (1985).
- f. Source: Swygert (1994).
- g. Morning traffic traveling to E-Area.
- h. Maximum number of construction workers (Hess 1995a, b).

**Table 4-6. Projected SRS hazardous and radioactive waste shipments by truck.a**

Waste Type	Destination	Total Shipments	No-action alternative (1994 baseline traffic) <sup>b</sup>
Hazardous	Onsite/offsite	101,437	14
Low-level	Onsite	1,559	7
Mixed	Onsite/offsite	58,349	8
Transuranic <sup>c</sup>	Onsite	3,790	1
Total Shipments per day			

- a. To arrive at shipments per day, the total number of waste shipments estimated for the 30 years considered in this eis was divided by 30 to determine estimated shipments per year. These numbers were divided by 250, which represents working days in a calendar year, to determine shipments per day.
- b. Shipments per day. 1994 baseline traffic is assumed to equal the no-action alternative using expected waste volumes.
- c. Includes mixed and nonmixed transuranic waste shipments.

#### 4.1.11.2 Transportation

DOE used the Radtran (Neuhauser and Kanipe 1992) computer codes to model the transportation of radioactive materials. These computer codes were configured with applicable SRS demographics and transportation accident rates (HNUS 1995a). The parameters for the Radtran analysis include the package dose rate, the number of packages per shipment, the number of shipments, the distance traveled, the fraction of travel in rural, suburban, and (for offsite transportation) urban population zones, traffic counts, travel speed, and type of highway traveled. Transport of radioactive material within a particular facility was excluded from this assessment because it involves operational transfers that are not defined as transportation and that would be included in facility accidents (e.g., Section 4.1.13). A more detailed breakdown of the transportation analysis by waste type is provided in Appendix E. Other model assumptions and input parameters are described in HNUS (1995a).

DOE analyzed the impacts that transportation of low-level, mixed, transuranic, and hazardous wastes would have on individuals located onsite and offsite. Doses from incident-free (normal) transport of waste over 30 years and from postulated transportation accidents involving radioactive waste were calculated for each alternative. Finally, health effects, expressed as the number of excess latent cancer

fatalities associated with the estimated doses, were calculated by multiplying the resultant occupational and general public doses by the risk factors of 0.0004 (for occupational health) and 0.0005 (for the general public) excess latent cancer fatalities per person-rem (ICRP 1991). For individuals, the calculated value represents the additional probability of developing a latent fatal cancer.

The Axair89Q (Hess 1995c) computer code uses SRS-specific meteorological data to model releases offsite from postulated onsite accidents. Axair89Q conservatively calculates the offsite individual and population doses because it uses very conservative air quality parameters (99.5 percent of the time the actual meteorology at SRS is less severe than that used by the model). For the transportation analyses, seven hypothetical human receptor groups were identified:

- **Uninvolved worker:** The SRS employee who is not assigned to the transportation activity but is located along the normal transportation route at an assumed distance of 30 meters (98 feet) and would be exposed to radiation from the normal transport shipment. Doses are reported in units of rem.
- **Uninvolved workers:** The collective SRS employee population not assigned to the transportation activity that would receive external or internal radiation exposure from normal onsite shipments and accidents. About 7,000 SRS employees would be exposed to routine shipments and as many as 6,000 could be exposed to radiation in the event of an accident. Doses are reported in units of person-rem.
- **Involved workers:** The collective SRS employee population assigned to the transportation activity (i.e., two transport crew and six package handlers per shipment) that would receive external radiation exposure from normal transport of shipments. These workers are allowed to receive a greater radiation dose than the general public. Doses are reported in units of person-rem.
- **Offsite maximally exposed individual:** The member of the public located at the point along the SRS boundary that receives the highest ground-level radioactive material concentration and who would receive external or internal radiation exposure from an onsite transportation accident. Doses are reported in units of rem.
- **Offsite population:** The members of the public in the compass sector most likely to experience the maximum collective dose due to radioactive material released from an onsite transportation accident. Approximately 182,000 people are considered part of the offsite population. Doses are reported in units of person-rem.
- **Remote maximally exposed individual:** The member of the public located along the offsite transportation route who would receive radiation exposure from normal transport. Doses are reported in units of rem.
- **Remote population:** Members of the public (as many as 1,837 people per square kilometer) along the offsite transportation route who would receive external or internal radiation exposure from normal shipments and accidents. Members of the remote population who would be exposed to incident-free shipments by rail number about 200,000, and about 130,000 for truck shipments. As many as 3 million people have the potential to be exposed to offsite accidents involving the transport of radioactive wastes.

#### **4.1.11.2.1 Incident-Free Radiological Impacts**

The magnitude of incident-free impacts depends on the dose rate at the surface of the transport vehicle, the exposure time, and the number of people exposed. Radiological consequences of incident-free transport would result from external exposure to radiation by the vehicle crew and package handlers and by the uninvolved workers along the transportation route (including those in vehicles sharing the route at the time of transport). For each waste and package type, external dose rates at 1 meter (3.3 feet) from the transport vehicle were calculated and used to calculate incident-free consequences to onsite receptors (HNUS 1995a). Duration of exposure depends on the speed of the transport vehicle and the distance it travels. Additionally, occupational exposure time depends on the number of shipments and how long it takes to load each transport vehicle.

Annual incident-free doses for the no-action alternative are shown in Table 4-7. The uninvolved worker dose represents the maximum annual exposure from each waste type (shown in Appendix E). Using conservative assumptions, involved workers would experience the highest doses because they would be closest to the waste. Of the waste types handled by these workers, low-level waste would deliver the highest dose due to the types of radionuclides present.

**Table 4-7. Annual dose and associated excess latent cancer fatalities**  
latent cancer fatalities  
Latent cancer fatalities from incident-free onsite transport of radioactive material under the no-action alternative.

The concepts of fractions of fatalities may be applied to estimate the effects of exposing a population to radiation. For example, in a population of 100,000 people exposed only to background radiation (0.3 rem per year), 15 latent cancer fatalities per year would be inferred to be caused by the radiation ( $100,000 \text{ persons} \times 0.3 \text{ rem per year} \times 0.0005 \text{ latent cancer fatalities per person-rem} = 15 \text{ latent cancer fatalities per year}$ ).

Sometimes calculations of the number of latent cancer fatalities associated with radiation exposure do not yield whole numbers, and, especially in environmental applications, may yield numbers less than 1.0. For example, if a population of 100,000 were exposed as above, but to a total dose of only 0.001 rem, the collective dose would be 100 person-rem, and the corresponding estimated number of latent cancer fatalities would be 0.05 ( $100,000 \text{ persons} \times 0.001 \text{ rem} \times 0.0005 \text{ latent cancer fatalities per person-rem} = 0.05 \text{ latent fatal cancers}$ ).

In this instance, 0.05 is the average number of deaths that would result if the same exposure situation were applied to many different groups of 100,000 people. In most groups, no one (0 people) would incur a latent cancer fatality from the 0.001 rem dose each member would have received. In a small fraction of the groups, 1 latent fatal cancer would result; in exceptionally few groups, 2 or more latent fatal cancers would occur. The average number of deaths over all of the groups would be 0.05 latent fatal cancers (just as the average of 0, 0, 0, and 1 is 1/4, or 0.25). The most likely outcome is 0 latent cancer fatalities.

#### 4.1.11.2.2 Radiological Transportation Accident Impacts

How great the consequences of an accident are depends on the amount of radioactive contamination to which the individual(s) are exposed, how long they are exposed, and the number of people exposed. DOE considered both the consequence and probability of vehicle accidents in the

transportation impacts model. The joint probability of a given severity of accident occurring for each type of waste shipped was calculated based on the probability of a range of impact forces that a package could receive in a hypothetical accident (NRC 1977), vehicle accident rates, and number of miles traveled. The severity of an accident is determined by the amount of damage to the package and subsequent release of material. Joint probabilities of a given accident severity greater than approximately  $1 \times 10^{-7}$  were selected for further analysis to determine the magnitude of accident consequences. Dispersion of radioactive material from the damaged package, combined with assumed release fractions, the fraction of released material that becomes airborne, and the fraction of airborne material that is of a size capable of being breathed in, is modeled to calculate the amount of radioactive contamination to which the individuals(s) are exposed. Generally, the requirements for package integrity and transport vehicles for onsite waste shipments are not as stringent as for transportation on public highways where package and vehicle requirements are regulated by the Department of Transportation and the Nuclear Regulatory Commission. Consequently, impacts from onsite accidents would be much greater than those for offsite accidents, because it is assumed that larger fractions of material would be released in an onsite accident.

Accident probabilities are best understood by assuming that many trips occur for a given type of transportation event (i.e., shipping low-level waste to an offsite facility). The number of trips when an accident occurs for a given number of trips is the accident probability. For example, if on a single trip, there was an accident, the probability of having an accident would be 1. If there was a second trip without an accident, the number of trips with accidents which occurred overall (1 out of 2 possible) would be one-half (0.5). However, since the number of accidents can only be whole numbers (i.e., it is impossible to have half an accident), the probability of having an accident is now 1 out of 2 trips, or 0.5, or 50 percent probability. Note that the probability is a unitless number.

Over the 30-year analysis period, for all accidents resulting in any consequence, the total probability of an accident involving low-level waste would be 0.49; from mixed waste, it would be 0.52; and from transuranic waste, it would be 0.038. The most probable accidents would not result in a dose because radioactive material would not be released. Table 4-8 presents the consequences to both onsite and offsite receptors from high consequence (low probability) postulated accidents. The results indicate that the highest consequences would result from accidents involving the release of transuranic waste and occur through inhalation of high-energy alpha particles associated with transuranic nuclides.

**Table 4-8.** Annual accident probabilities, doses associated with those accidents, and associated excess latent cancer fatalitiesLatent cancer fatalitiesLatent cancer fatalities from high consequence (low probability) accidents involving the transport of radioactive materials under the no-action alternative.

The greatest consequence from postulated transportation accidents involving radioactive materials would be to the uninvolved workers (with an estimated 120 latent cancer fatalitiesLatent cancer fatalities; Table 4-8) as the result of an accident in which it is assumed that all of the conservatively estimated transuranic nuclides in a transuranic waste container would be released over an area of about 3 square kilometers (1.1 square miles) in a single transportation accident. The number of cancers would be highest for the uninvolved workers due to the larger number of people that would be exposed and the greater amount of radioactive material to which they would potentially be exposed. Over the 30-year analysis period, the probability that an accident of this consequence would occur is  $1.44 \times 10^{-6}$ .

#### 4.1.11.2.3 Nonradiological Transportation Accident Impacts

Since the actions evaluated in this eis do not introduce new dispersible, nonradioactive, hazardous materials to the SRS transportation system, DOE reviewed the results of prior transportation accident analyses (WSRC 1991c, 1992b) for applicability to the waste management alternatives. These analyses were based on the facilities, equipment, and operations representative of SRS conditions between 1982 and mid-1985, when SRS's chemical inventory and the movement of chemicals were at their peak. Because the actions evaluated in this eis involve the shipment of hazardous waste (rather than hazardous materials whose concentrations are generally much larger) and current and future site chemical inventories would be less than those previously analyzed (WSRC 1992b), this prior conclusion that there would be very small onsite and offsite impacts from onsite shipments of hazardous waste remains valid. This conclusion is further supported by recent analysis (see Section 4.1.11.1) which determined that accidents resulting in the release of hazardous material would occur, on average, only once in 6 years for the no-action alternative. This analysis also predicted that for the scenario with the largest impacts (alternative B – maximum waste forecast), accidents resulting in the release of hazardous material would occur, on average, only once in 4 years. Based on the waste forecasts (Appendix A) over the next 30 years, most hazardous waste shipments (91 percent) are expected to be soil and debris. These wastes do not contain high concentrations of toxic materials, and accidental release of these solid materials would not lead to an explosion hazard or atmospheric release of dangerous chemicals. Accident consequences are therefore expected to be localized and result in minimal impacts to human health or the environment. These impacts are considered very small and are not discussed further in this document.

#### 4.1.11.3 Noise

As discussed in Section 3.11.3, studies have concluded that, because of the remote locations of the SRS operational areas, no known conditions are associated with existing onsite noise sources that adversely affect offsite individuals (NUS 1991; DOE 1990, 1991, 1993b). Since the vast majority of waste management activities occur onsite, adverse impacts due to noise are not expected for any of the alternatives or waste forecasts. Thus, noise impacts are not discussed further in this eis.

	Min.	Exp.	Max.
No Action			
A			
B			
C			

#### 4.1.12 OCCUPATIONAL AND PUBLIC HEALTH

This section discusses the radiological and nonradiological exposures due to normal operations under the no-action alternative and subsequent impacts to the public and workers. This analysis, further discussed in Section 4.1.12.1.1, shows that the health effects (specifically latent cancer fatalities) latent

cancer fatalities (latent cancer fatalities) associated with the no-action alternative are themselves small and are small relative to those normally expected in the worker and regional area population groups from other causes.

The principal potential human health effect from exposure to low levels of radiation is cancer. Human health effects from exposure to chemicals may be toxic effects (e.g., nervous system disorders) or cancer. For the purpose of this analysis, radiological carcinogenic effects are expressed as the number of fatal cancers for populations and the maximum probability of death of a maximally exposed individual. Nonradiological carcinogenic effects are expressed as the total number of fatal and non-fatal cancers.

In addition to latent cancer fatalities, other health effects could result from environmental and occupational exposures to radiation. These effects include nonfatal cancers among the exposed population and genetic effects in subsequent generations. To enable comparisons with fatal cancer risk, the International Commission of Radiological Protection (ICRP 1991) suggested use of detriment weighting factors which take into consideration the curability rate of non-fatal cancers and the reduced quality of life associated with non-fatal cancer and heredity effect. The commission recommended probability coefficients (risk factors) for the general public of 0.0001 per person-rem for non-fatal cancers and 0.00013 per person-rem for hereditary effects. Both of these values are approximately a factor of four lower than the risk factors for fatal cancer. Therefore, this EIS presents estimated effects of radiation only in terms of latent cancer fatalities, because that is the major health effect from exposure to radiation.

For nonradiological health effects, risks are estimated as the incremental probability of an individual developing cancer (either fatal or nonfatal) over a lifetime as a result of exposure to the potential carcinogen. The overall potential for cancer posed by exposure to multiple chemicals is calculated by summing the chemical-specific cancer risks to give a total individual lifetime cancer risk.

For radiological emissions from facilities considered under the no-action alternative, the largest occupational and public health effects were projected from the following facilities: (1) for involved workers, the transuranic and alpha waste storage pads and the F- and H-Area (high-level waste) tank farms; (2) for the public and uninvolved workers, the M-Area Vendor Treatment Facility; and (3) for the public only, the F/H-Area Effluent Treatment Facility. To simplify the calculation, 30-year process volumes were used to estimate occupational and public health effects.

Nonradiological air emissions are expected to produce very small health impacts for involved and uninvolved workers. Although overall public health impacts would be very small, the greatest contribution to these impacts would occur due to emissions from benzene waste generated from the Defense Waste Processing Facility, including In-Tank Precipitation.

#### **4.1.12.1 Occupational Health and Safety**

##### **4.1.12.1.1 Radiological Impacts**

Doses to involved workers were estimated based on a review of exposures resulting from waste management activities for the no-action alternative. Direct radiation and inhalation would be the largest exposure pathways. Doses to uninvolved workers were calculated using the MAXIGASP computer code (see Section 4.1.12.2). An uninvolved worker was conservatively assumed to be located 100 meters (328 feet) from the release point (of the affected facility) for 80 hours per week; another was conservatively assumed to be located 640 meters (2,100 feet) from the release point for 80 hours per week. The weekly exposure period was conservatively estimated to ensure that doses to overtime workers were not underestimated. Doses were estimated for the inhalation, ground contamination, and plume immersion exposure pathways. Data required to calculate doses to the uninvolved worker population are not currently available; however, dose to an individual uninvolved worker at 100 meters (328 feet) and 640 meters (2,100 feet) would bound the impact to the individual members of the population.

The incremental worker doses (the increase in dose due to activities under the no-action alternative) are given in Table 4-9. DOE regulations (10 CFR 835) require that annual doses to individual workers not exceed 5 rem per year. DOE assumes that exposure to the maximally exposed involved worker at SRS would not exceed 0.8 rem per year due to administrative controls (WSRC 1994d).

From these radiological doses, estimates of latent cancer fatalities were calculated using the conversion factor for workers of 0.0004 latent cancer fatality per rem (ICRP 1991). Based on this factor, the probability that the average involved worker would develop a fatal cancer sometime during his lifetime as the result of a single year's exposure to waste management-generated radiation would be  $1.0 \times 10^{-5}$ , or approximately 1 in 100,000. For the worker exposed to the administrative limit (0.8 rem), the probability of developing a fatal cancer sometime in his lifetime as a result of a single year's exposure would be  $3.2 \times 10^{-4}$ , or approximately 3 in 10,000. For the total involved workforce, the collective radiation dose could produce up to 0.022 additional fatal cancer as the result of a single year's exposure; over the 30-year period the involved workers could have 0.65 additional fatal cancer as a result of exposure. The probability of any individual uninvolved worker developing a fatal cancer as a result of the estimated exposure would be very small (Table 4-9).

The calculated numbers of fatal cancers due to worker exposure to radiation can be compared with the number of fatal cancers that would normally be expected among the workers during their lifetimes. Population statistics indicate that, of the U.S. population which died in 1990, 23.5 percent died of cancer (CDC 1993). If this percentage of deaths from cancer remains constant, 23.5 percent of the U.S. population will develop a fatal cancer during their lifetime. Therefore, in the group of 2,088 involved workers, about 491 would normally be expected to die of cancer.

The probability of developing a radiation-induced fatal cancer associated with the no-action alternative is much less than the probability of developing a fatal cancer from other causes.

**Table 4-9. Worker radiological doses<sup>a</sup> and resulting health effects associated with the no-action alternative.**

#### 4.1.12.1.2 Nonradiological Impacts

Potential nonradiological impacts to SRS workers were considered for air emissions emanating from the following facilities: Defense Waste Processing Facility, including In-Tank Precipitation; M-Area Vendor Treatment Facility; M-Area Air Stripper; hazardous and mixed waste storage building; and the E-Area organic waste storage tanks. Occupational health impacts to employees in the Defense Waste Processing Facility and In-Tank Precipitation are presented in the Final Supplemental Environmental Impact Statement Defense Waste Processing Facility.

Table 4-10 presents a comparison between Occupational Safety and Health Administration-permissible exposure limit values and potential exposures to employees at both 100 meters (328 feet) and 640 meters (2,100 feet) from each facility considered. Downwind concentrations were calculated using EPA's TSCREEN model. In all cases, employee exposure would be below Occupational Safety and Health Administration-permissible exposure limits, and health impacts would be expected to be very small.

#### **4.1.12.1.3 Noise**

Occupational exposures to noise are controlled through the contractor hearing conservation program activities in Industrial Hygiene Manual 4Q, Procedure 501. This program implements the contractor requirements for identifying, evaluating, and controlling noise exposures to meet the requirements of 29 CFR 1910.95, Occupational Noise Exposure. All personnel with 8-hour time weighted average exposures greater than 85 dBA are enrolled in the program. Significant aspects of the hearing conservation program include: routine noise exposure monitoring, audiometric testing, hearing protection, employee information and training, and recordkeeping.

#### **4.1.12.2 Public Health and Safety**

##### **4.1.12.2.1 Radiological Impacts**

To estimate the health effects associated with the no-action alternative on the public, it was necessary to calculate radiological doses to individuals and population groups. Estimates of latent cancer fatalities were then calculated using the conversion factor of 0.0005 latent cancer fatality per rem for the general population (ICRP 1991). This factor is slightly higher than that for workers (Section 4.1.12.1), because infants and children are part of the general population.

**Table 4-10.** Calculated maximum 8-hour average pollutant concentrations (micrograms per cubic meter of air).

Effects are estimated for two separate population groups: (1) the 620,100 people living within 80 kilometers (50 miles) of SRS and the 871,000 people living within 80 kilometers (50 miles) of the

offsite facility who would be exposed to atmospheric releases; and (2) the 65,000 people using the Savannah River who would be exposed to releases to the river (Arnett, Karapatakis, and Mamatey 1994). Impacts are estimated for the maximally exposed individual in each of these population groups.

To facilitate the prediction of the radiological doses associated with the no-action alternative, current and future waste management practices at SRS were assessed. Wastes were aggregated into treatability groups to estimate the radionuclide releases to air and water.

Airborne radiological releases were converted to doses using the MAXIGASP and POPGASP computer codes (Hamby 1992). Doses were calculated using dose factors provided in Simpkins (1994a). These codes calculate the dose to a hypothetical maximally exposed individual at the SRS boundary and the collective dose to the population within an 80-kilometer (50-mile) radius, respectively. The inhalation, food ingestion, ground contamination, and plume exposure pathways were evaluated. Both codes utilize the GASPAR (Eckerman et al. 1980) and XOQDOQ (Sagendorf, Croll, and Sandusky 1982) modules. GASPAR and XOQDOQ have been adapted for use at SRS (Hamby 1992 and Bauer 1991, respectively).

For the assessments, DOE assumed that the population would remain constant over the 30-year period of analysis. This assumption is justified because (1) current estimates indicate that the population will increase by less than 15 percent during this period (HNUS 1995b), (2) there are uncertainties in the determination of year-to-year population distributions, and (3) although the absolute impacts would increase proportionately with population growth, the relative impact comparison between alternatives would not be affected.

Calculated atmospheric doses are given in Table 4-11 (releases from operation of the Defense Waste Processing Facility are not included). The annual doses (0.00012 millirem to the offsite maximally exposed individual and 0.00029 person-rem to the offsite population) would be small fractions of the dose from total SRS airborne releases in 1993 [0.11 millirem to the offsite maximally exposed individual and 7.6 person-rem to the population within 80 kilometers (50 miles) of SRS (Arnett, Karapatakis, and Mamatey 1994)]. Doses from 1993 operations were well within the EPA requirements given in 40 CFR 161 and adopted by DOE in Order 5400.5, which allow an annual dose limit to the offsite maximally exposed individual of 10 millirem from all airborne releases.

Waterborne releases were converted to doses using the LADTAP XL computer code (Hamby 1991). This code calculates the dose to a hypothetical maximally exposed individual along the Savannah River just downstream of SRS, and to the population using the Savannah River from SRS to the Atlantic Ocean. Fish ingestion, water ingestion, and recreational exposure pathways were evaluated. The aqueous dose-producing-releases were discharges from the F/H-Area Effluent Treatment Facility; seeps from groundwatergroundwaterGroundwater discharges were too small to affect the totals. Table 4.11.

**Table 4-11.** Radiological doses<sup>a</sup> associated with the no-action alternative and resulting health effects to the public.

As was done for the atmospheric assessments, the population was assumed to remain constant over the 30-year period of analysis.

Calculated doses from releases to water are given in Table 4-11. The annual doses (0.00069 millirem

to the offsite maximally exposed individual and 0.0068 person-rem to the offsite population) would be small fractions of the doses from total SRS releases to water in 1993 [0.14 millirem to the maximally exposed member of the public and 1.5 person-rem to the population using the Savannah River from SRS to the Atlantic Ocean (Arnett, Karapatakis, and Mamatey 1994)]. Doses from 1993 operations were well within the regulatory requirements specified in DOE Order 5400.5 and by EPA in 40 CFR 141, which allow an annual dose limit to the offsite maximally exposed individual of 4 millirem from drinking water.

Using the fatal-cancer-per-rem dose factor given above, the probability of the maximally exposed individual developing a fatal cancer and the numbers of fatal cancers that could occur in the regional population under the no-action alternative were calculated (Table 4-11). The probability of the maximally exposed individual dying of cancer as a result of 30 years of exposure to radiation from activities under the no-action alternative is slightly more than 1 in 100 million; the number of additional Table 4-11. Radiological doses and resulting health effects to the public associated with the no-action alternative.fatal cancers that might occur in the regional population for this same exposure period would be  $1.1 \times 10^{-4}$ .

About 23.5 percent of the U.S. population die from cancer from all causes (Section 4.1.12.1); accordingly, the probability of an individual dying of cancer is 0.235, or approximately 1 in 4. In a population of 620,100 people (the number of people living within 80 kilometers [50 miles] of SRS), the number of people expected to die of cancer is 145,700. In a population of 65,000 (the number of people using the Savannah River as a source of drinking water), the number of people expected to die of cancer is 15,275. Thus, the incidence of radiation-induced fatal cancers associated with the no-action alternative (see Table 4-11) would be much smaller than the incidence of cancers from all causes.

#### 4.1.12.2.2 Nonradiological Impacts

Potential nonradiological impacts to individuals residing offsite were considered for both criteria and carcinogenic pollutants. Maximum SRS boundary-line concentrations for criteria pollutants are discussed in Section 4.1.5.

For routine releases from operating facilities under the no-action alternative, criteria pollutant concentrations would be within both state and federal ambient air quality standards and are discussed in Section 4.1.5. During periods of construction under normal operating conditions, the criteria pollutant concentrations at the SRS boundary would not exceed air quality standards, and very small health impacts would be expected from criteria pollutant emissions.

Offsite risks due to carcinogens were calculated using the Industrial Source Complex 2 model for the same facilities discussed in Section 4.1.12.1.2. The assumptions in the model are conservative. Emissions of carcinogenic compounds were estimated using permitted values for facilities not currently operating (e.g., the Defense Waste Processing Facility) and emission factors for facilities currently operating (e.g., aqueous and organic wasteorganic waste storage tanksorganic waste storage tanks) (EPA 1985). Table 4-12 shows estimated latent cancers based on EPA's Integrated RiskRisk Information System database (EPA 1994).

**Table 4-12.** Estimated probability of excess latent cancers in the SRS offsite population.

The unit risk (cancer risk per unit of air concentration) for a chemical is the highest lifetime risk (over 70 years) of developing cancer (either fatal or nonfatal) when continuously exposed to the chemical at an air concentration of 1 microgram per cubic meter. As shown in Table 4-12, the estimated lifetime risk associated with routine emissions from facilities included in the no-action alternative is approximately 2 in  $1.0 \times 10^7$ . Health impacts to the public would be very small.

#### 4.1.12.2.3 Environmental Justice Assessment

Environmental justice has assumed an increasingly prominent role in the environmental movement over the past decade. In general, the term "environmental justice" refers to fair treatment of all races, cultures, and income levels with respect to laws, policies, and government actions. In February 1994, Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," was released. This order directs federal agencies to identify and address, as appropriate, disproportionately high and adverse effects of its programs, policies, and activities on minority and low-income populations. Executive Order 12898 also directs the Administrator of EPA to convene an interagency federal working group on environmental justice (referred to below as the Working Group). The Working Group will provide guidance to federal agencies for identifying disproportionately high and adverse human health or environmental effects on minority and low-income populations. The Working Group has not yet issued this guidance. It has developed working draft definitions. Although the definitions are in draft form, DOE used them in the analysis for this eis. In coordination with the Working Group, DOE is developing internal guidance on implementation of the executive order. DOE's internal guidance was used in preparing this eis.

This eis addresses environmental justice concerns in three areas: (1) potential air emissions, (2) potential impacts from transportation of wastes offsite, and (3) potential impacts from consuming fish and game. Based on these analyses, DOE concluded that none of the alternatives would have disproportionate adverse effects on minority populations or low-income communities.

Although adverse health effects are not expected under the no-action alternative, in the spirit of Executive Order 12898 an analysis was performed to determine whether any impacts would have been disproportionately distributed. Figures 3-12 and 3-13 identify census tracts with significant proportions of people of color or low income. This section presents the predicted average radiation doses that would be received under the no-action alternative by individuals in these census tracts and compares them to the predicted per capita doses received in the remaining tracts within the 80-kilometer (50-mile) radius of SRS. This section also discusses impacts of doses received in the downstream communities from liquid effluents from all alternatives and cases.

Figure 4-6 shows a wheel with 22.5-degree sectors and concentric rings from 16 to 80 kilometers (10 to 50 miles) radiating at 16-kilometer (10-mile) intervals from the center of SRS. A fraction of the total dose (see Appendix E) was calculated for each sector based on meteorological data (Simpkins 1994b), the sector wheel was laid over the census tract map, and each tract was assigned to a sector. For purposes of this analysis, if a tract fell in more than one sector, the tract was assigned to the sector with the highest dose.

DOE analyzed the effects by comparing the per capita dose received by each type of community to

the other types of communities within a defined region. To eliminate the possibility that effects to a small community close to SRS would be diluted and masked by including it with a larger community located farther from SRS, comparisons were made within increasingly larger concentric circles, the radii of which increase in 16-kilometer (10-mile) increments.

Figure 4-6. Identification of annular sectors around SRS. (See Appendix E for dose fractions by sector.)

To determine the per capita radiation dose in each census tract for the no-action alternative, the number of people in each tract was multiplied by that tract's dose value to obtain a total population dose for each tract. These population doses were summed over each concentric circle and divided by the total community population to obtain a mean per capita dose for each circular area. The dose determined for each tract was compared to this mean dose. Figure 4-7 illustrates these results for the no-action alternative. Appendix E provides the supporting data.

As shown, the per capita dose is extremely small for each community type. This analysis indicates that communities of people of color (in which the minority population is equal to or greater than 35 percent of the total population) or low income (in which the number of low income persons is equal to or greater than 25 percent of the total population) would not be disproportionately affected by atmospheric releases.

Table 4-11 lists predicted doses to the offsite maximally exposed individual and to the downstream population from exposure to water resources. The doses reflect people using the Savannah River for drinking water, sports, and food (fish). Because the communities of people of color or low income living in the areas downstream from SRS are well distributed and because persons in the downstream region would not be affected (the 30-year dose to the offsite maximally exposed individual for all alternatives and forecasts would be 0.021 millirem), there are no disparate adverse impacts on low-income or minority communities in the downstream areas for any of the alternatives.

The distribution of carcinogen and criteria pollutant emissions due to routine operations, and of criteria pollutants from construction activities, would be essentially identical to those presented for airborne radiological emissions, so people of color and the poor would not be disproportionately affected by non-radiological emissions under any of the alternatives. Because non-radiological pollutant emissions have only very small impacts in any of the alternatives, and are not disproportionately distributed among types of communities, there are no Environmental Justice concerns related to these pollutants for any of the alternatives.

Environmental justice concerns were also considered for the impacts associated with the offsite transportation of hazardous and radioactive waste that would occur under the alternatives. A recent impact analysis (see Section 4.1.11.1) determined that for the no-action alternative, accidents resulting in the release of hazardous material would be expected to occur, on average, only once in 6 years (i.e., five accidents resulting in hazardous material release over the 30-year period of this eis). The impact analysis determined that for the scenario with largest impacts (alternative B – maximum waste forecast), accidents involving the release of hazardous material would be expected to occur, on average, only once in 4 years. In addition to the expected frequency of such accidents, their impacts can be mitigated by Figure 4-7. Dose to individuals in communities within 80 kilometers (50 miles) of the SRS. The dose is calculated based on radiological emissions under the no-action alternative. existing training and technology for controlling spills from vehicles. Because these rare events are expected to occur randomly in time with equal distribution throughout various types of

communities, there are no disproportionate adverse impacts on poor or minority communities from transportation of hazardous and radioactive waste for any of the alternatives evaluated in this EIS.

DOE also considered impacts associated with consumption of wildlife from SRS and fish from the Savannah River from the perspective of Environmental Justice. Doses to the maximally exposed hunter and fisherman (see Section 3.12.1.2) have been determined to be 57 and 1.3 millirem, respectively. These analyses assumed that the hunter consumed 153 kilograms (337 pounds) of meat from deer and hogs taken from SRS and 19 kilograms (42 pounds) of fish from the Savannah River at the mouth of Steel Creek each year. If the rate of fish consumption, for conservatism, was doubled to 39 kilograms (84 pounds) per year, the total annual dose to an individual consuming both game and fish would be 59.6 millirem or 59.6 percent of the DOE annual limit (DOE 1993c). A dose of this magnitude would result in an annual probability of contracting a latent fatal cancer of  $3.0 \times 10^{-5}$  (approximately 3 in 100,000). It is highly unlikely that communities of people of color or low income consume game and fish at a rate greater than that calculated for the maximally exposed individual who both hunts and fishes, as that person is assumed to eat 421 pounds of fish and game each year. Because the doses received by this maximally exposed individual from fish and game are not significant, there would be no disproportionate adverse impacts from consumption of wildlife by people of color or low income.

#### **4.1.13 FACILITY ACCIDENTS**

This section summarizes the risks to workers and members of the public from potential accidents at facilities associated with the various waste types under the no-action alternative. An accident is a series of unexpected or undesirable events leading to a release of radioactive or hazardous material within a facility or to the environment. Appendix F provides further detail and discussion regarding the accident analysis.

##### **4.1.13.1 Methodology**

Accident assessment is based on potential accidents identified and described in safety documentation for SRS facilities and on material inventories at SRS facilities that support the no-action alternative. Accidents include events resulting from external initiators (e.g., vehicle crashes, nearby explosions), internal initiators (e.g., equipment failures, human error), and natural phenomena initiators (e.g., earthquakes, tornadoes). Radioactive and hazardous material releases resulting from accidents are considered in this analysis.

The accident scenarios selected for this evaluation were chosen to represent the full spectrum of events which could occur (i.e., both high- and low-frequency events and large- and small-consequence events). The frequency ranges, as presented in Table 4-13, are as follows: anticipated accidents, unlikely accidents, extremely unlikely accidents, and beyond-extremely-unlikely accidents. A more complete discussion on accident frequencies is given in Section F.2 of Appendix F. However, it should be noted that all frequency ranges may not have representative accident scenarios identified for them. Accident scenarios in the beyond-extremely-unlikely frequency range are so unlikely that they often are not analyzed in safety documentation.

Radiological consequences are defined in terms of (1) the dose to an individual and collective dose to a population; and (2) latent fatal cancers from a postulated accident. The human health effect of concern is the development of latent fatal cancers. The International Commission on Radiological Protection (ICRP) has made specific recommendations for quantifying these health effects (ICRP 1991). The results of these health effects are presented in terms of increased latent fatal cancers (i.e., number of additional fatal cancers expected in the population) calculated using ICRP-60 conversion factors of 0.0005 for the public and 0.0004 for onsite workers if the effective dose equivalent is less than 20 rem. For individual doses of 20 rem or more, the ICRP-60 conversion factors are doubled. For hazardous materials, consequences are defined in terms of airborne chemical concentrations.

Radiological doses for the postulated accident scenarios were extracted from information provided in the following technical reports: Bounding Accident Determination for the Accident Input Analysis of the SRS Waste Management Environmental Impact Statement (WSRC 1994e), Solid Waste Accident Analysis in Support of the Savannah River Waste Management Environmental Impact Statement (WSRC 1994f), and the Liquid Waste Accident Analysis in Support of the Savannah River Waste Management Environmental Impact Statement (WSRC 1994g). These technical reports compiled pre-existing safety documentation addressing the risks of operating waste management facilities. Figure 4-8 is a flowchart for the preparation of radiological accident analysis information. No new analyses were performed because existing documentation adequately supported a quantitative or qualitative estimation of potential impacts, as required by the National Environmental Policy Act (NEPA). As indicated by the last step of the flowchart (Figure 4-8), impacts resulting from the expected, minimum, and maximum forecast are evaluated and discussed for the representative bounding accidents. However, the no-action alternative only considers the expected waste forecast.

The figures presented in Section 4.1.13.2 reflect the increase in cancers estimated using the above conversion factors. The AXAIR89QAXAIR89Q computer code (WSRC 1994h) predicted impacts in terms of dose for onsite and offsite receptor groups. The code then calculated the collective dose to the affected population living within 80 kilometers (50 miles) of SRS. This population exposure is given as person-rem dose equivalent, as if the accident occurred. Increases in latent fatal cancers as the result of an accident would be in addition to the number of cancers expected from all other causes.

The point estimate of increased risk is provided to allow consideration of accidents that may not have the highest consequence, but due to a higher estimated frequency, may pose a greater risk. An example of this concept for the no-action alternative can be seen in the representative bounding accidents selected for liquid high-level radioactive waste. An accidental release of radioactive material due to a pressurization and breach at the Replacement High-Level Waste Evaporator would result in the greatest consequence, which would be  $6.8 \times 10^{-1}$  latent fatal cancer per occurrence for the offsite population within 80 kilometers (50 miles). Because this accident is estimated to occur once every 20,000 years, a time-weighted average of these consequences over the accident frequency time span (i.e., consequences times frequency) results in an annualized point estimate of increased risk of  $3.4 \times 10^{-5}$  latent fatal cancer per year. A release due to a feed line break at the Replacement High-Level Waste Evaporator produces lower consequences than the pressurization and breach scenario:  $9.1 \times 10^{-3}$  latent fatal cancer per occurrence. However, this accident is estimated to occur every 14 years, resulting in a point estimate of increased risk of  $6.3 \times 10^{-4}$  latent fatal cancer per year. Thus, by factoring in the accident probability, a more accurate comparison of the resulting risks can be made.

To fully understand the hazards associated with SRS facilities under the alternatives considered in

this eis, it is necessary to evaluate potential accidents involving both hazardous and radiological materials. For chemically toxic materials, several government agencies recommend quantifying chemical concentrations that cause short-term effects as threshold values of concentrations in air. Figure 4-8. Radiological accident analysis process flowchart. Because the long-term health consequences of human exposure to hazardous materials are not as well understood as those related to radiation exposure, a determination of potential health effects from exposures to hazardous materials is more subjective than a determination of health effects from exposure to radiation. Therefore, the consequences from accidents involving hazardous materials are in terms of airborne concentrations at various distances from the accident location. Emergency Response Planning Guidelines (ERPG) values are the only well-documented parameters developed specifically for use in evaluating the health consequences of exposure of the general public to accidental releases of hazardous materials (WSRC 1992c). ERPG-3 values represent the threshold concentration for lethal effects, while ERPG-2 values represent the threshold concentration for severe or irreversible health effects in exposed populations (see Appendix F, Table F-3). The quantities and airborne concentrations of toxic chemicals at the various receptor locations were extracted from information provided in the technical reports (WSRC 1994g, h) supporting this eis. The analysis presented in Appendix F presents facility-specific chemical hazards.

**Table 4-13. Accident frequency categories.a**

Frequency category	Frequency range (accidents per year) <sup>b</sup>
Anticipated accidents	$10^{-1} > p > 10^{-2}$
Unlikely accidents	$10^{-2} > p > 10^{-4}$
Extremely unlikely accidents	$10^{-4} > p > 10^{-6}$
Beyond-extremely-unlikely accidents	$10^{-6} > p$

<sup>a</sup> The frequencies for accidents are from DOE Standard 3009-94 (DOE 1994b).

<sup>b</sup>  $x > y$ . The number "x" is greater than or equal to the number "y." Conversely, the number "y" is less than or equal to the number "x" (e.g.,  $5 > 4 > 3$ ).

#### 4.1.13.2 Summary of Accident Impacts

Figures 4-9 through 4-12 summarize the projected impacts of radiological accidents to the population, the offsite maximally exposed individual, and uninvolved workers at 100 and 640 meters (328 and 2,100 feet), respectively. Data required to calculate uninvolved worker population doses are not currently available; however, doses to uninvolved workers at 100 and 640 meters (328 and 2,100 feet) would bound impacts to the individual member of the population. For example, Figure 4-9 shows the estimated increase in latent fatal cancers resulting from the estimated population dose for the representative bounding accidents selected for each waste type. Representative bounding accidents are identified by each frequency range for each applicable waste type. An anticipated accident (i.e., one occurring between once every 10 years and once every 100 years) involving low-level and mixed waste is the accident scenario under the no-action alternative that would present the

greatest risk to the population within 80 kilometers (50 miles) of SRS (see Figure 4-9). This accident scenario would increase the risk to the population within 80 kilometers (50 miles) by  $1.7 \times 10^{-2}$  latent fatal cancer per year.

Figures 4-10, 4-11, and 4-12 present similar information for the offsite maximally exposed individual, uninvolved workers at 640 meters (2,100 feet), and uninvolved workers at 100 meters (328 feet), respectively. An anticipated accident involving either mixed waste or low-level waste would pose the greatest risk to the offsite maximally exposed individual (Figure 4-10) and the uninvolved worker at 640 meters (2,100 feet) (Figure 4-11). The anticipated accident increases the risk to the offsite Figure 4-9. Figure 4-10. Figure 4-11. Figure 4-12. maximally exposed individual by  $3.3 \times 10^{-7}$  latent fatal cancer per year and to the uninvolved worker at 640 meters (2,100 feet) by  $1.8 \times 10^{-5}$  latent fatal cancer per year.

An accident involving either mixed waste or low-level waste would also pose the greatest risk to the uninvolved worker at 100 meters (328 feet) (Figure 4-12). This accident scenario would increase the risk to the uninvolved worker at 100 meters (328 feet) by  $1.0 \times 10^{-3}$  latent fatal cancer per year.

Except for an accident in the transuranic waste characterization/certification facility (discussed under alternatives A, B, and C), radiological accidents considered in this EIS would not result in doses that would result in substantial acute or latent health effects.

A complete summary of all representative bounding accidents considered for the no-action alternative is presented in Table 4-14. This table provides accident descriptions, annual frequency of occurrence, accident scenario. Details regarding the individual postulated accident scenarios associated with the various waste types are provided in Appendix F.

For all the waste types considered, a summary of the chemical hazards associated with the no-action alternative estimated to exceed ERPG-2 values is presented in Table 4-15. For the uninvolved worker at 100 meters (328 feet), nine chemical-release scenarios are estimated to exceed ERPG-3 values. Moreover, another five chemical-release scenarios estimate airborne concentrations that exceed ERPG-2 values where equivalent ERPG-3 values were not identified. For the offsite maximally exposed individual, no chemical-release scenario identified airborne concentrations that exceeded ERPG-3 values. Only the lead-release scenario estimates airborne concentrations that exceed the ERPG-2 guidelines (Table F-25 in Appendix F).

Furthermore, the benzene-release scenarios (see Table F-19) result from an explosion and tornado at the Organic Waste Storage Tank, respectively. Under the no-action alternative, the Consolidated Incineration Facility is unavailable as a benzene treatment option. As a result, an additional four organic wasteorganic waste storage tanksorganic waste storage tanks would be required for the management of benzene mixed waste. Therefore, DOE assumes an increase in the likelihood that a catastrophic benzene release could occur (i.e., more organic waste storage tanks that could explode or be hit by a tornado).

In addition to the risk to human health, secondary impacts from postulated accidents on plant and animal resources, water resources, the economy, national defense, environmental contamination, threatened and endangered species, land use, and Native American treaty rights are considered. DOE believes secondary impacts from postulated accidents as assessed in Appendix F, Section F.7 to be minor. Table 4-14. Summary of representative bounding accidents for the no-action alternative. aTable 4-15. Summary of chemical hazards associated with the no-action alternative estimated to exceed

ERPG-2a values.

	Min.	Exp.	Max.
No Action			
A			
B			
C			





## CHAPTER 5. FEDERAL AND STATE LAWS, CONSULTATIONS, AND REQUIREMENTS

This chapter identifies regulatory requirements and evaluates their applicability to the alternatives considered in this environmental impact statement (eis). These requirements are established by major federal statutes that impose requirements on the U.S. Department of Energy (DOE). In addition, there are other federal and state laws, Executive Orders, DOE Orders, regulations, and other compliance orders and agreements applicable to the management of waste at the Savannah River Site (SRS). More detailed information on SRS regulatory requirements for waste management is available in *Final Environmental Impact Statement, Waste Management Activities for Groundwater Protection* (DOE 1987). Existing environmental permits at SRS are listed in Appendix B of the *Savannah River Site Environmental Report for 1993* (Arnett, Karapatakis, and Mamatey 1994). Table 5-1 summarizes the permit and approval status of SRS waste management facilities.

Section 5.1 discusses regulatory requirements applicable to the no-action alternative. Section 5.2 addresses differences in the regulatory requirements that apply to the no-action alternative and the other alternatives, and any differences related to the waste volumes. A number of requirements apply to all the alternatives. When that is the case, Section 5.1 includes a discussion of the requirement, which is not repeated in Section 5.2.

	Min.	Exp.	Max.
No Action			
A			
B			
C			

### 5.1 No-Action Alternative

#### 5.1.1 NATIONAL ENVIRONMENTAL POLICY ACT

The National Environmental Policy Act (NEPA) of 1969 (42 USC §4321 *et seq.*) requires federal agencies to evaluate the effect proposed actions would have on the quality of the human environment and to document this evaluation with a detailed statement. NEPA requires consideration of environmental impacts of an action during the planning and decisionmaking stages of a project.

The Council on Environmental Quality has issued regulations that federal agencies must follow (40 CFR 1500 - 1508); agencies were also directed to develop their own regulations to ensure compliance with NEPA requirements. DOE's regulations can be found at 10 CFR 1021. An agency is required to prepare an eis when it proposes a major federal action that may significantly affect the environment.

**Status** - Analyses presented in this EIS describe the environmental impacts of the alternatives. Additional NEPA analyses may be required before some facilities could be constructed.

### 5.1.2 ATOMIC ENERGY ACT

The Atomic Energy Act of 1954 (42 USC § 201 *et seq.*) makes the federal government responsible for regulatory control of the production, possession, and use of three types of radioactive material: source, special nuclear, and byproducts. The Atomic Energy Act also requires DOE to establish standards that protect health and minimize dangers to life or property from activities under DOE's jurisdiction. Pursuant to the Atomic Energy Act, DOE established an extensive system of standards and requirements, called DOE Orders, to ensure compliance with the Atomic Energy Act. The Atomic Energy Act and the Reorganization Plan No. 3 of 1970 [5 USC (app. at 1343)] and other related statutes gave the U.S. Environmental Protection Agency (EPA) responsibility and authority for developing generally applicable environmental standards for protecting the environment from radioactive material. EPA has promulgated several regulations under this authority, including "Environmental Radiation Protection Standards for the Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes" (40 CFR 191).

In response to public comments during the scoping period, DOE presents in Appendix H a comparison of alternative regulatory approaches for the disposal of low-level waste. The appendix presents an analysis of the similarities and differences in requirements established by DOE and the Nuclear Regulatory Commission for the disposal of low-level waste. Table H-1 correlates specific DOE and Nuclear Regulatory Commission requirements. The conclusion of the analysis is that DOE regulations are substantially equivalent to Nuclear Regulatory Commission regulations.

Appendix H also provides a comparative analysis of DOE and Nuclear Regulatory Commission low-level waste disposal requirements with EPA requirements for a hazardous waste landfill. The analysis indicates that the vaults proposed for disposal of low-level waste at SRS (discussed in Appendix B.8) exceed the EPA hazardous waste landfill requirements.

**Status** - Construction, prestartup evaluations, and operation of radioactive waste management facilities will meet the requirements in DOE Orders and other applicable regulations.

### 5.1.3 COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT

The Comprehensive Environmental Response, Compensation, and Liability Act (42 USC §9601 *et seq.*) (CERCLA; also called the Superfund Act) is administered by EPA. It provides a statutory framework for the cleanup of waste sites containing hazardous substances and requires that facilities have an emergency response program in the event of a release (or threat of release) of a hazardous substance to the environment. CERCLA also includes requirements of reporting to state and federal agencies releases of certain hazardous substances in excess of specified amounts. CERCLA and Executive Order 12580, "Superfund Implementation," require that federal facilities comply with the Act. Releases of hazardous substances occurring during cleanups at waste management facilities are

subject to both CERCLA's requirements and to the requirements of DOE Order 5000.3B, "Occurrence Reporting and Processing of Operations Information."

**Status** - DOE, the South Carolina Department of Health and Environmental Control (SCDHEC), and EPA have signed a Federal Facility Agreement to coordinate cleanups at SRS, as required by Section 120 of CERCLA. Since 1989, SRS has conducted cleanup activities under the framework established in the draft Federal Facility Agreement. The comprehensive remediation of SRS will continue as directed by the Federal Facility Agreement.

#### **5.1.4 EMERGENCY PLANNING AND COMMUNITY RIGHT-TO-KNOW ACT**

The Emergency Planning and Community Right-to-Know Act of 1986 (42 USC §11001 *et seq.*) requires emergency planning and notice to communities and government agencies of the presence and release of specific chemicals. EPA implements the Act under regulations found at 40 CFR 355, 370, and 372. Under Subtitle A of this Act, federal facilities, including those owned by DOE, provide a variety of information (such as inventories of specific chemicals used or stored, and releases that occur from these facilities) to state emergency response commissions and local emergency planning committees to ensure that emergency plans are ready to respond to accidental releases of hazardous substances. Executive Order 12856, "Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements," requires federal agencies to comply with the Act.

**Status** - Each year SRS submits hazardous chemical inventory and toxic release inventory reports to SCDHEC and to local emergency planning organizations in Aiken, Allendale, and Barnwell Counties, South Carolina. Changes in facility operating status will lead to changes in chemical inventories and use of toxic chemicals; the hazardous chemical inventory and toxic release inventory reports will reflect these changes.

#### **5.1.5 RESOURCE CONSERVATION AND RECOVERY ACT**

The Resource Conservation and Recovery Act (RCRA) regulates the treatment, storage, and disposal of hazardous and solid waste. RCRA and Executive Order 12088, "Federal Compliance with Pollution Control Standards," require federal facilities to comply with RCRA's requirements. Any state that wants to administer and enforce a hazardous waste program under the requirements of RCRA may apply to EPA for authorization of its program. EPA regulations implementing RCRA are found at 40 CFR 260-280. These regulations define hazardous wastes and set forth requirements governing transporting, handling, treating, storing, and disposing of hazardous wastes.

The regulations imposed on managing hazardous wastes vary according to the type and quantity of waste. The method of treatment, storage, and disposal also impacts the extent and complexity of the requirements. RCRA establishes three distinct regulatory programs for different types of waste:

**Hazardous and Mixed Waste** - EPA has delegated regulatory responsibility over hazardous and mixed (containing both radioactive and hazardous components) wastes to SCDHEC. EPA retains authority to restrict storage and disposal of certain kinds of hazardous wastes, which are referred to as "land disposal restriction wastes." Under the authority of the South Carolina Hazardous Waste Management

Act, SCDHEC has established a program for regulating hazardous waste management (South Carolina Hazardous Waste Management Regulations R.61-79.260 through 270). SCDHEC is currently developing programs that will allow EPA to delegate authority over land-disposal-restriction wastes.

DOE and EPA signed a Federal Facility Compliance Agreement regarding land disposal restriction mixed wastes. Among other things, the Agreement requires SRS to provide status reports on construction and operation of various waste management facilities and to obtain permits for the construction and operation of additional facilities to meet SRS's treatment needs for mixed waste. SRS has provided, and will continue to provide, these reports and is preparing the required permit applications.

Underground Storage Tanks - Requirements under RCRA for underground storage tanks apply to tanks containing hazardous substances or petroleum products. Under the South Carolina Underground Storage Tank Act, SCDHEC established a program for implementing RCRA requirements and has issued permits for diesel fuel storage tanks at several SRS waste management facilities. Tanks with high-level radioactive waste are not regulated under RCRA; they are regulated under the Clean Water Act. Below-grade hazardous waste storage tanks are not regulated as underground storage tanks but as hazardous waste.

Nonhazardous Solid Waste - Under the authority of the South Carolina Pollution Control Act and the South Carolina Solid Waste Policy and Management Act, SCDHEC established a program for regulating nonhazardous solid waste disposal units. South Carolina Municipal Solid Waste Landfill Regulations (R.61-107.258) implement RCRA regulations. South Carolina Construction, Demolition, and Land Clearing Debris Landfill Regulations (R.61-107.11) regulate landfills for the disposal of construction debris. South Carolina Industrial Landfill Regulations (R.61-66) regulate industrial landfills. Nonhazardous solid waste is not within the scope of this eis.

**Status** - The SRS RCRA Part B permit was issued in 1987 and modified in 1992. The permit covers storage of wastes at four buildings, treatment at the Consolidated Incineration Facility, and maintenance and groundwater remediation at three closed waste units. Other waste management facilities at SRS are presently operating under interim status: SRS submitted to SCDHEC a permit application that covers those facilities' activities and they can continue to operate in conformance with regulatory requirements while applications are reviewed by the regulatory agencies and a final permit decision is issued. Additional waste management facilities (e.g., F- and H-Area tank farms, Replacement HighLevel Waste Evaporator) are currently operating under or will operate under Clean Water Act permits. Although these facilities manage hazardous wastes, they are exempt from RCRA permitting requirements under its exclusion for wastewater treatment facilities.

Under the no-action alternative, commitments under the Land Disposal Restrictions Federal Facility Compliance Agreement to treat mixed waste would not be met because only ongoing waste management activities (primarily storage) would be continued.

The no-action alternative includes continued storage and limited ongoing treatment activities at existing waste management facilities that are permitted or operating under interim status. The no-action alternative includes several additional waste management activities that have not yet occurred, but for which NEPA reviews have been completed or will be completed prior to issuing a Record of Decision for this eis. These activities include retrieval, sampling, and overpacking of transuranic waste drums from mounded storage pads; preparation of waste (size reduction and repackaging) in

anticipation of treatment; construction and operation of the MArea Vendor Treatment Facility; and operation of the Mixed Waste Storage Buildings.

### 5.1.6 FEDERAL FACILITY COMPLIANCE ACT

The Federal Facility Compliance Act, enacted on October 6, 1992, waives sovereign immunity for fines and penalties for violations of RCRA at federal facilities. However, DOE's immunity continues if DOE prepares plans for developing the treatment capacity for mixed waste stored or generated at its facilities. The appropriate state agency or EPA must then issue a consent order requiring compliance with the plan. DOE is not subject to fines and penalties for RCRA violations involving mixed waste as long as it is in compliance with an approved plan and meets all other applicable regulations.

**Status** - DOE published the Interim Mixed Waste Inventory Report in April 1993, annual updates, and periodic updates since, describing its inventory of mixed wastes and treatment capabilities. SRS prepared a site treatment plan (WSRC 1995), which identifies DOE's preferred approach for treating mixed waste at SRS. Under the no-action alternative, commitments under the site treatment plan would not be met because only ongoing waste management activities would be continued. The treatment capacity required by SRS's plan would not be available and SRS would probably lose its immunity from fines and penalties.

### 5.1.7 CLEAN WATER ACT

The objectives of the Clean Water Act are to restore and maintain the chemical, physical, and biological integrity of the nation waters. The Clean Water Act prohibits the "discharge of toxic pollutants in toxic amounts" to navigable waters of the United States. Section 313 requires all branches of the federal government to comply with federal, state, interstate, and local requirements.

In addition to setting water quality standards for the nation's waterways, the Clean Water Act establishes guidelines and limitations for discharges from point-sources and a permitting program known as the National Pollutant Discharge Elimination System. The National Pollutant Discharge Elimination System program is administered by the Water Management Division of EPA pursuant to regulations at 40 CFR 122 *et seq.*

The Clean Water Act also requires that EPA establish regulations for permits for stormwater discharges associated with industrial activity. Although such discharges require National Pollutant Discharge Elimination System permits, regulations for separate stormwater permits have not yet been issued by EPA.

EPA has overall responsibility for enforcing the Clean Water Act, but has delegated to SCDHEC primary enforcement authority for waters located within South Carolina. Under the South Carolina Pollution Control Act, SCDHEC operates a permitting program. The Clean Water Act and state regulations do not apply to DOE discharges of radionuclides, which are subject to the Atomic Energy Act.

**Status** - SCDHEC has issued Clean Water Act permits for the F- and H-Area tank farms, Defense Waste Processing Facility, ZArea Saltstone Facility, Replacement High-Level Waste Evaporator, F/H-Area Effluent Treatment Facility, and M-Area Liquid Effluent Treatment Facility. SCDHEC approved certain discharges from the outfalls at these facilities. DOE has submitted an industrial wastewater treatment permit application for the M-Area Vendor Treatment Facility. SRS is currently in compliance with Clean Water Act requirements.

### **5.1.8 SAFE DRINKING WATER ACT**

The Safe Drinking Water Act protects the quality of public water supplies and other sources of drinking water. It establishes drinking water quality standards that must be met. The Act and Executive Order 12088 direct federal facilities to comply with the Safe Drinking Water Act. EPA has promulgated regulations implementing the Safe Drinking Water Act at 40 CFR 100 - 149. The regulations specify that the average annual concentration of man-made radionuclides in drinking water as delivered to the user shall not produce a dose equivalent to the total body or an internal organ greater than 4 millirem of beta activity per year. EPA has overall regulatory responsibility for the Safe Drinking Water Act, but has delegated primary enforcement responsibility to SCDHEC for public water systems in South Carolina. Under the authority of the South Carolina Safe Drinking Water Act, SCDHEC has established a drinking water regulatory program. At SRS, Westinghouse Savannah River Company operates under the SCDHEC permit program for construction of water supplies. Under this program, Westinghouse Savannah River Company may construct water line extensions that are less than or equal to 2,500 feet long without obtaining construction and operating permits; water line extensions longer than 2,500 feet require formal construction and operating permits.

**Status** - Westinghouse Savannah River Company obtained a construction permit for the water line extension that will serve the Consolidated Incineration Facility.

### **5.1.9 CLEAN AIR ACT**

The Clean Air Act establishes a national program to protect air quality and regulates sources of air pollution. Requirements include permits, emissions and operating standards, and monitoring. The Act is intended to "protect and enhance the quality of the Nation's air resources so as to promote the public health and welfare and the productive capacity of its population." Section 118 of the Act and Executive Order 12028 require that each federal agency, such as DOE, with jurisdiction over any property or facility that might result in the discharge of air pollutants, comply with "all federal, state, interstate, and local requirements" with regard to the control and abatement of air pollution.

The Act requires EPA to establish National Ambient Air Quality Standards as necessary to protect public health, with an adequate margin of safety, from any known or anticipated effect of a regulated pollutant. It also requires establishment of national standards of performance for new or modified stationary sources of air pollutants (42 USC §7411) and requires specific emission increases to be evaluated to prevent significant deteriorations in air quality. Hazardous air pollutants, including radionuclides, are regulated separately. Air emissions are regulated by EPA in 40 CFR 50 - 99. In

particular, radionuclide emissions are regulated under the National Emission Standard for Hazardous Air Pollutants program (40 CFR 61).

EPA has overall enforcement responsibility through a regulatory program (40 CFR 50 - 87); it can delegate primary authority to states. For facilities located within South Carolina, EPA has retained authority over DOE radionuclide emissions (40 CFR 61) and has delegated to SCDHEC lead responsibility for the rest of the regulated pollutants and other requirements. Under the authority of the South Carolina Pollution Control Act, SCDHEC established the state's air pollution control program. SCDHEC issues construction permits for construction and testing of facilities, and operating permits after satisfactory startup testing and inspection.

**Status** - The Air Quality Control construction permit for the Consolidated Incineration Facility was granted by SCDHEC on November 25, 1992. Emergency power diesel generators are covered under this permit. The M-Area Vendor Treatment Facility emergency diesel generator is exempt from permitting requirements because of its limited capacity and expected use. SCDHEC has granted a permitting exemption for the emergency diesel generator at the Replacement HighLevel Waste Evaporator. SRS is currently in compliance with the requirements of the Clean Air Act.

#### **5.1.10 ENDANGERED SPECIES ACT AND OTHER STATUTES**

The Endangered Species Act is intended to prevent the further decline of endangered and threatened species and to restore these species and their habitats. The Endangered Species Act also promotes biodiversity of genes, communities, and ecosystems. The U.S. Department of Commerce (National Marine Fisheries Service) and the U.S. Department of the Interior (U.S. Fish and Wildlife Service) jointly administer the Act. Section 7 of the Act requires federal agencies to consult with the National Marine Fisheries Service or the U.S. Fish and Wildlife Service, as appropriate, to ensure that any action it authorizes, funds, or performs is not likely to jeopardize the continued existence of any endangered or threatened species or to result in the destruction or adverse modification of any critical habitat of such species unless the agency receives an exemption in accordance with Section 7(h).

Several other statutes require federal and state agencies to consider impacts that their actions would have on biological resources. These acts include the Fish and Wildlife Coordination Act, the Anadromous Fish Conservation Act, the Migratory Bird Treaty Act, the Bald Eagle Protection Act, and the South Carolina Nongame and Endangered Species Conservation Act.

**Status** - Prior to disturbing undeveloped land, DOE would consult with the U.S. Fish and Wildlife Service to determine the type and scope of a required biological assessment. This consultation would provide DOE with the information necessary to avoid or mitigate impacts to threatened and endangered species. Appendix J documents DOE's consultation with the U.S. Fish and Wildlife Service.

#### **5.1.11 EXECUTIVE ORDERS 11990 AND 11988**

Executive Order 11990, "Protection of Wetlands," requires government agencies to avoid short- and long-term adverse impacts to wetlands whenever a practicable alternative exists. Executive Order 11988, "Floodplain Management," directs federal agencies to establish procedures to ensure

that the potential effects of flood hazards and floodplain management are considered for any action undertaken. Impacts to floodplains are to be avoided to the extent practicable. DOE issued regulations (10 CFR 1022) that establish procedures for compliance with these Executive Orders.

**Status** - Because no activities in wetlands would occur under the no-action alternative, no wetlands would be destroyed.

### 5.1.12 EXECUTIVE ORDER 12898

Executive Order 12898, "Environmental Justice in Minority and Low-Income Populations," requires that each federal agency "make environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects due to its programs, policies, or activities on minority or low-income populations."

**Status** - This eis incorporates environmental justice into its analyses of the no-action alternative.

### 5.1.13 CULTURAL RESOURCES

Cultural resources on SRS are subject to the American Indian Religious Freedom Act (42 USC § 1996), the Native American Graves Protection and Repatriation Act (25 USC § 3001), and the National Historic Preservation Act (16 USC § 470 *et seq.*). The American Indian Religious Freedom Act of 1978 reaffirms Native American religious freedom under the First Amendment and protects and preserves the inherent and constitutional right of American Indians to believe, express, and exercise their traditional religions. The Act requires that federal actions avoid interfering with access to sacred locations and traditional resources that are integral to the practice of those religions. The Native American Graves Protection and Repatriation Act of 1990 directs the Secretary of the Interior to promote repatriation of federal archaeological collections and collections held by museums receiving federal funding that are culturally affiliated with Native American tribes. The American Indian Religious Freedom Act and the Native American Graves Protection and Repatriation Act require DOE to notify affected tribes if sites and items of religious importance or human remains and other objects belonging to Native Americans are discovered on SRS.

Construction of waste management facilities might unearth artifacts and destroy historic sites regulated by these statutes. Upon discovery (and before excavation) of human remains, the affiliated tribe(s) would be consulted to ensure the appropriate disposition of the human remains and any other objects. DOE has committed to providing the Yuchi Tribal Organization, Inc., the National Council of the Muskogee Creek, and the Indian People's Muskogee Tribal Town Confederacy copies of environmental impact documentation for DOE activities in the Central Savannah River Valley.

The National Historic Preservation Act, as amended, provides that sites with significant national historic value be placed on the National Register of Historic Places. There are no permits or certifications required under the Act. However, if a particular federal activity may impact a historic property, consultation with the Advisory Council on Historic Preservation is required and will usually lead to a Memorandum of Agreement containing stipulations that must be followed to minimize adverse impacts. Coordination with the State Historic Preservation Officer also ensures that

potentially significant sites are properly identified and appropriate mitigation actions are implemented.

**Status** - DOE will comply with these Acts with regard to artifacts discovered during implementation of the no-action alternative.

## 5.2 Other Alternatives

This section discusses the permit status for the construction and operation of waste management facilities that would be implemented under the moderate treatment configuration (alternative B). It also applies to facilities that would be implemented under the limited treatment (alternative A) and extensive treatment (alternative C) configurations.

	Min.	Exp.	Max.
No Action			
A			
B			
C			

### 5.2.1 EXPECTED WASTE FORECAST

**National Environmental Policy Act** - No change from the no-action alternative.

**Atomic Energy Act** - No change from the no-action alternative.

**Comprehensive Environmental Response, Compensation, and Liability Act** - No change from the no-action alternative.

**Emergency Planning and Community Right-to-Know Act** - No change from the no-action alternative.

**Resource Conservation and Recovery Act** - Facilities required for implementation of the moderate treatment alternative would be subject to RCRA, the South Carolina Hazardous Waste Management Act, and the South Carolina Hazardous Waste Management Location Standards.

All activities under the moderate treatment configuration would have to be coordinated and compatible with requirements of the Land Disposal Restrictions Federal Facility Compliance Agreement.

Treatment of low volume and one-time only waste streams in accordance with generator accumulation requirements (South Carolina Code of Laws of 1976, as amended, R.61-79.262.34) or via treatability studies is being considered. RCRA permitting requirements would not apply to these situations.

**Federal Facility Compliance Act** - The *SRS Proposed Site Treatment Plan* (WSRC 1995), which identifies DOE's preferred approach to treating mixed wastes at SRS, was submitted to the state of South Carolina in accordance with requirements of the Federal Facility Compliance Act. The site treatment plan addresses mixed wastes currently stored and those wastes SRS anticipates will be generated in the next 5 years. All mixed waste management activities would have to comply with the requirements of the approved site treatment plan and its implementing order.

**Clean Water Act** - No change from the no-action alternative.

**Safe Drinking Water Act** - DOE does not know at this time which permitting requirements would apply to proposed projects, because the precise location and water supply requirements for these projects are unknown. Permits may be required if water-line extensions are needed for additional waste management facilities considered in the alternatives.

**Clean Air Act** - The emission permit for construction of the Consolidated Incineration Facility was issued by SCDHEC in November 1992. Before the Consolidated Incineration Facility can operate, approval for startup must be granted. Air permits would be required for emergency power diesel generators for proposed new waste management facilities. At SRS, air quality permits must also be acquired before a construction permit is granted.

**Endangered Species Act and Other Statutes** - The U.S. Fish and Wildlife Service has concurred with DOE's conclusion that DOE's plans to construct and operate additional waste management facilities within the uncleared portions of EArea should not affect any threatened or endangered species. The concurrence letters are included in Appendix J.

**Executive Orders 11990 and 11988** - Facilities and activities considered under the three alternatives may affect wetlands or floodplains, but this cannot be determined until the precise location of any additional facilities is known. Impacts to any wetland that could not be avoided would need to be identified as an unavoidable and irretrievable loss in this eis. Under the alternatives, any impacts to wetlands would be lessened by mitigation as required by the Clean Water Act. Under 10 CFR 1022, floodplain and wetland assessments would be required for any proposed action in a floodplain or wetland.

**Executive Order 12898** - No change from the no-action alternative.

**Cultural Resources** - No change from the no-action alternative.

No Action	Min.	Exp.	Max.
A			
B			
C			

### 5.2.2 MINIMUM WASTE FORECAST

The difference between the minimum and expected waste forecasts is that certain facilities may not

be needed. Since the waste volumes anticipated in these configurations would require less treatment capacity, SRS may be able to implement additional low-volume or one-time only waste management options that would not require permit modifications (Clean Air Act, Clean Water Act, RCRA). SRS would receive wastes that it had the best capability to treat or dispose of, and would ship some of its own wastes to facilities better equipped to manage them.

	Min.	Exp.	Max.
No Action			
A			
B			
C			

### 5.2.3 MAXIMUM WASTE FORECAST

Regulatory requirements for the maximum waste forecast are the same as those for the expected case. However, permit modifications (Clean Air Act, Clean Water Act, and RCRA) might be required to accommodate the larger volumes of waste. Waste volumes anticipated under this forecast would require additional treatment, storage, and disposal capacity. Under this forecast, the current SRS RCRA permit would need to be modified to increase permitted and/or interim status waste management process capacities. The potential exists to impact wetlands with this forecast. Any impacts to wetlands would be mitigated, as required by the Clean Water Act.

### 5.3 References

Arnett, M. W., L. K. Karapatakis, and A. R. Mamatey, 1994, *Savannah River Site Environmental Report for 1993*, WSRC-TR-94-075, Westinghouse Savannah River Company, Aiken, South Carolina.

DOE (U.S. Department of Energy), 1987, *Final Environmental Impact Statement, Waste Management Activities for Groundwater Protection, Savannah River Plant, Aiken, South Carolina*, DOE/eis-0120, Savannah River Operations Office, Aiken, South Carolina.

WSRC (Westinghouse Savannah River Company), 1995, *Savannah River Site Proposed Site Treatment Plant*, Westinghouse Savannah River Company, Aiken, South Carolina, WSRC-TR-94-0608.





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**EDUCATION:** B.S., Chemistry, Lebanon Valley College, 1950

**TECHNICAL EXPERIENCE:** Forty years experience in nuclear and fossil energy, water and wastewater management, and environmental science.

**eis RESPONSIBILITY:** Prepared Foreword and Summary. Provided technical input to the Glossary, no-action alternative sections in Chapters 2 and 4, and mitigating measures section in Chapter 4.

**NAME: ROBIN F. CALLICOTT**

**AFFILIATION:** Halliburton NUS Corporation

**EDUCATION:** B.A., History, University of South Carolina, 1982

**TECHNICAL EXPERIENCE:** Nine years experience evaluating legislative documents and writing material based on implications of Federal legislation pertaining to environment, health, judiciary, and trade matters.

**eis RESPONSIBILITY:** Public participation lead. Contributed to the preparation of references sections.

**NAME: SHAWN D. CHESNEY**

**AFFILIATION:** Halliburton NUS Corporation

**EDUCATION:** M.S., Health Physics, University of Florida, 1994

B.S., Health Physics, Bloomsburg University of Pennsylvania, 1993

**TECHNICAL EXPERIENCE:** Six years experience in environmental health physics.

**eis RESPONSIBILITY:** Provided technical input to Appendix E. Reviewed health and transportation sections in Chapter 4.

**NAME: STEPHEN A. DANKER**

**AFFILIATION:** U.S. Department of Energy, Savannah River Operations Office

**EDUCATION:** M.S., Wildlife Ecology, Mississippi State University, 1979

B.S., Biology, St. Bernard College, 1970

**TECHNICAL EXPERIENCE:** Twelve years experience in environmental impact statements and impact analyses, and wetlands ecology.

**eis RESPONSIBILITY:** DOE-SR reviewer for final eis.

**NAME: GREGORY C. DeCAMP**

**AFFILIATION:** Halliburton NUS Corporation

**EDUCATION:** M.S., Biology, Bowling Green State University, 1976

B.S., Chemistry, Xavier University, 1968

**TECHNICAL EXPERIENCE:** Twenty years applied environmental science and regulatory experience, including managing environmental program evaluations, environmental baseline studies and assessments, and environmental compliance programs involving hazardous waste management.

**eis RESPONSIBILITY:** Reviewed Appendix H.

**NAME: ALAN A. ECKMYRE**

**AFFILIATION:** Halliburton NUS Corporation

**EDUCATION:** B.E., Nuclear Engineering, State University of New York, 1981

B.S., Business Administration, New York Institute of Technology, 1979

**TECHNICAL EXPERIENCE:** Sixteen years experience in nuclear engineering and environmental consulting.

**eis RESPONSIBILITY:** Prepared Consolidated Incineration Facility section in Appendix B; waste and materials section in Chapter 3; and waste generation section in Chapter 4. Provided technical input to low-level waste treatment, storage, and disposal; and mixed waste treatment, storage, and disposal sections in Chapter 2.

**NAME: ROBERT T. EDGAR, Ph.D.**

**AFFILIATION:** Halliburton NUS Corporation

**EDUCATION:** Ph.D., Environmental Science, University of Texas at Dallas, 1987

M.S., Environmental Science, University of Texas at Dallas, 1977

M.S., Meteorology, New York University, 1971

B.S., Mathematics, University of North Texas, 1969

**TECHNICAL EXPERIENCE:** Sixteen years technical and managerial experience in air quality monitoring.

**eis RESPONSIBILITY:** Prepared air resources and nonradiological health sections in Chapters 3 and 4.

**NAME: DANIEL M. EVANS**

**AFFILIATION:** Halliburton NUS Corporation

**EDUCATION:** M.S., Planning, University of Tennessee at Knoxville, 1985

B.A., Political Science, Knox College, 1976

**TECHNICAL EXPERIENCE:** Seventeen years experience in National Environmental Policy Act project management and technical review, socioeconomic impact analysis, transportation impact analysis, and air traffic impact analysis.

**eis RESPONSIBILITY:** Management reviewer.

**NAME: MICHAEL R. FALLIN**

**AFFILIATION:** Halliburton NUS Corporation

**EDUCATION:** B.S., Mechanical and Nuclear Engineering, University of Maryland, 1977

**TECHNICAL EXPERIENCE:** Twenty years experience including mechanical and radiological waste system modification and design, and thermal hydraulic, heat transfer and radiological analyses.

**eis RESPONSIBILITY:** Contributed to the preparation of Appendix D.

**NAME: D. SCOTT FLICKINGER**

**AFFILIATION:** Halliburton NUS Corporation

**EDUCATION:** M.E.M., Natural Resources Economics and Policy, Duke University, 1988

B.A., Biology and Political Science, Western Maryland College, 1985

**TECHNICAL EXPERIENCE:** Six years experience working with Comprehensive Environmental Response, Compensation, and Liability Act, and Resource Conservation and Recovery Act issues concerning permitting and waste handling.

**eis RESPONSIBILITY:** Prepared transuranic waste sections in Chapter 2, and Appendix G.

**NAME: LESTER G. GERMANY**

**AFFILIATION:** Halliburton NUS Corporation

**EDUCATION:** B.S., Geology, Louisiana Tech University, 1967

**TECHNICAL EXPERIENCE:** Eight years experience with geoscience and environmental projects including groundwater protection.

**eis RESPONSIBILITY:** Prepared geologic resources sections in Chapters 3 and 4.

**NAME: MORTON I. GOLDMAN, Sc.D.**

**AFFILIATION:** Halliburton NUS Corporation

**EDUCATION:** Sc.D., Massachusetts Institute of Technology, 1960

M.S., Nuclear Engineering, Massachusetts Institute of Technology, 1960

M.S., Sanitary Engineering, Massachusetts Institute of Technology, 1960

B.S., Civil Engineering, New York University, 1948

**TECHNICAL EXPERIENCE:** Forty-five years experience managing complex technical projects including activities in site evaluation and selection, safety analysis, waste management system evaluations, environmental assessments, and impact evaluations for nuclear powerplants and industrial facilities.

**eis RESPONSIBILITY:** Senior technical reviewer. Prepared Appendix H.

**NAME: ANDREW R. GRAINGER**

**AFFILIATION:** U.S. Department of Energy, Savannah River Operations Office

**EDUCATION:** M.S., Wildlife Ecology, Utah State University, 1978

B.S., Natural Resources, Cornell University, 1975

**TECHNICAL EXPERIENCE:** Sixteen years experience in terrestrial ecology, facility siting, wetlands ecology, and endangered species.

**eis RESPONSIBILITY:** DOE-SR reviewer for Draft eis.

**NAME:** KRISTINE A. GUNTHER

**AFFILIATION:** Halliburton NUS Corporation

**EDUCATION:** M.B.A., The University of Alabama, 1992

B.A., Economics, Rhodes College, 1990

**TECHNICAL EXPERIENCE:** Two years experience in conducting socioeconomic studies.

TE

**eis RESPONSIBILITY:** Prepared socioeconomics and cultural resources sections in Chapters 3 and 4. Coordinated project scheduling for final eis.

**NAME:** KATHRYN B. HAUER

**AFFILIATION:** Halliburton NUS Corporation

**EDUCATION:** M.A., English, College of William and Mary, 1985

B.A., English, College of William and Mary, 1983

**TECHNICAL EXPERIENCE:** Eight years experience in technical writing, editing, and teaching in both government and business disciplines.

**eis RESPONSIBILITY:** Editor.

**NAME:** MARY N. HOGANSON

**AFFILIATION:** Halliburton NUS Corporation

**EDUCATION:** M.S., Biology, Winthrop College, 1989

B.S., Biology, Newberry College, 1984

**TECHNICAL EXPERIENCE:** Eight years experience in environmental work including waste minimization and pollution prevention.

**eis RESPONSIBILITY:** Prepared waste minimization and pollution prevention sections in Chapter 2. Provided technical input to waste minimization and pollution prevention strategy for low-level waste, storage and disposal; waste management/pollution prevention strategy for mixed waste; and waste management/pollution prevention strategy for transuranic waste sections in Chapter 2.

**NAME:** THOMAS HOLM-HANSEN

**AFFILIATION:** PRC Environmental Management, Inc.

**EDUCATION:** M.S., Environmental Health, University of Washington, 1981

B.S., Biological Sciences, University of Connecticut, 1978

**TECHNICAL EXPERIENCE:** Twelve years experience managing radioactive and hazardous waste at DOE sites. Experience includes research, technology transfer, and operations and consulting.

**eis RESPONSIBILITY:** Co-authored Appendix D.

**NAME: DALE T. HULS**

**AFFILIATION:** Halliburton NUS Corporation

**EDUCATION:** B.S.M.E., Mechanical Engineering, University of Florida, 1991

**TECHNICAL EXPERIENCE:** Ten years experience including the preparation of system analysis reports, special programs, and procedures regarding nuclear operations at SRS.

**eis RESPONSIBILITY:** Co-authored accidents sections in Chapter 4 and Appendix F.

**NAME: E. JONATHAN JACKSON**

**AFFILIATION:** Halliburton NUS Corporation

**EDUCATION:** M.S., Soil Science, University of Wisconsin-Madison, 1987

B.S., Molecular Biology, University of Wisconsin-Madison, 1981

**TECHNICAL EXPERIENCE:** Twelve years environmental experience including five years hazardous materials management and regulatory compliance.

**eis RESPONSIBILITY:** Provided technical input to decontamination and decommissioning and environmental restoration sections in Chapter 4.

**NAME: WILLIAM E. JOYCE**

**AFFILIATION:** Halliburton NUS Corporation

**EDUCATION:** B.S., Chemical Engineering, University of Connecticut, 1968

**TECHNICAL EXPERIENCE:** Twenty-five years experience in environmental assessments, radiological dose assessments, and transportation impacts.

**eis RESPONSIBILITY:** Provided technical input to radiological sections pertaining to occupational and public health in Chapter 4.

**NAME: KARA B. LEVINSON**

**AFFILIATION:** Halliburton NUS Corporation

**EDUCATION:** B.S., Civil Engineering, University of Pittsburgh, 1983

**TECHNICAL EXPERIENCE:** Eleven years experience including senior engineer responsibilities in the areas of hazardous waste management and air.

**eis RESPONSIBILITY:** Contributing author of waste forecast and hazardous waste sections in Chapter 2 and Appendix A. Assisted in preparation of Appendix B.

**NAME:** ANNE C. LOVELL

**AFFILIATION:** PRC Environmental Management, Inc.

**EDUCATION:** B.S., Chemical Engineering, Colorado School of Mines, 1985

**TECHNICAL EXPERIENCE:** Ten years experience in waste management including incineration, process engineering, engineering design, and innovative technologies.

**eis RESPONSIBILITY:** Co-authored Appendix D.

**NAME:** LISA A. MATIS

**AFFILIATION:** Halliburton NUS Corporation

**EDUCATION:** M.S., Mechanical Engineering, Stevens Institute of Technology, 1989

B.S., Chemical Engineering, Stanford University, 1984

**TECHNICAL EXPERIENCE:** Ten years experience as a chemical-environmental engineer including technical support in planning and controlling Resource Conservation and Recovery Act and Comprehensive Environmental Response, Compensation, and Liability Act compliance activities.

**eis RESPONSIBILITY:** Prepared hazardous and mixed waste treatment, storage, and disposal sections in Chapter 2. Provided technical input to Chapter 4 analyses. Technical reviewer.

**NAME:** ANDREW F. McCLURE, JR.

**AFFILIATION:** Halliburton NUS Corporation

**EDUCATION:** B.S., Chemical Engineering, Carnegie Mellon University, 1966

**TECHNICAL EXPERIENCE:** Forty years experience in the water/wastewater field, with an emphasis on wastewater treatment activities including permit applications, and permit implementation and monitoring/reporting.

**eis RESPONSIBILITY:** Prepared surface water sections in Chapters 3 and 4.

**NAME:** KEVIN M. MEEHAN

**AFFILIATION:** Halliburton NUS Corporation

**EDUCATION:** B.S., Mechanical Engineering, The Pennsylvania State University, 1990

TE

**TECHNICAL EXPERIENCE:** Four years experience in safety engineering and safety analysis.

**eis RESPONSIBILITY:** Co-authored accidents sections in Chapter 4 and Appendix F.

**NAME: ROBERT P. MOLINOWSKI**

**AFFILIATION:** PRC Environmental Management, Inc.

**EDUCATION:** B.S., Electrical Engineering, Florida Institute of Technology, 1988

**TECHNICAL EXPERIENCE:** Five years experience including engineering design and analysis review, and Naval nuclear operations and engineering.

**eis RESPONSIBILITY:** Co-authored Appendix D.

**NAME: LOUISE S. MOORE**

**AFFILIATION:** Halliburton NUS Corporation

**EDUCATION:** B.A., Geography, University of Maryland, 1968

**TECHNICAL EXPERIENCE:** Twenty years experience in developing and leading environmental projects, including 16 years in the energy field.

**eis RESPONSIBILITY:** Assistant Project Manager. Prepared Chapter 1. Prepared land use, aesthetic and scenic resources sections in Chapters 3 and 4. Coordinated project scheduling. Technical reviewer.

**NAME: PHILIP R. MOORE**

**AFFILIATION:** Halliburton NUS Corporation

**EDUCATION:** M.S., Wildlife Biology (Fisheries), Clemson University, 1983

Post-baccalaureate study, Zoology, Clemson University, 1977/1979

B.A., English, University of South Carolina, 1975

**TECHNICAL EXPERIENCE:** Ten years experience in environmental impact assessment of hydroelectric, fossil, and nuclear powerplants.

**eis RESPONSIBILITY:** Reviewed ecological resources section in Chapters 3 and 4.

**NAME: J. LYNN MYRICK**

**AFFILIATION:** Halliburton NUS Corporation

**EDUCATION:** M.S., Geosciences, University of Arizona, 1993

B.S., Geology and English, Vanderbilt University, 1991

**TECHNICAL EXPERIENCE:** Four years experience as a technical author and one year in environmental assessments.

**eis RESPONSIBILITY:** Editor. Assisted with preparation of references sections.

Performed number conversions.

**NAME: RICHARD S. NUGENT, Ph.D.**

**AFFILIATION:** Halliburton NUS Corporation

**EDUCATION:** Ph.D., Marine Sciences, University of Miami, 1970

M.S., Biology, Boston College, 1967

B.S., Biology, Boston College, 1964

**TECHNICAL EXPERIENCE:** Twenty-five years experience in aquatic ecology, water quality, thermal studies, and environmental impact statements.

**eis RESPONSIBILITY:** Assisted in document planning and identifying independent reviewers.

**NAME: MEGHAN O. SHIKOSKI**

**AFFILIATION:** Halliburton NUS Corporation

**EDUCATION:** M.S., Technical and Science Communication, Drexel University, 1989

B.S., Biology, Louisiana Tech University, 1986

**TECHNICAL EXPERIENCE:** Five years experience in environmental programs in both technical and management aspects.

**eis RESPONSIBILITY:** Prepared low-level waste treatment, storage and disposal, and liquid high-level waste treatment storage, and disposal sections in Chapter 2.

**NAME: JAMES L. OLIVER**

**AFFILIATION:** Halliburton NUS Corporation

**EDUCATION:** B.S., Biology (Fisheries), Murray State University, 1971

**TECHNICAL EXPERIENCE:** Twenty years experience in research and impact assessment projects for the U.S. Department of Interior and DOE. As Deputy Director of the Office of Environmental Sciences, provides reviews of environmental and natural resource management issues, and performs strategic planning for National Environmental Policy Act documentation for DOE.

**eis RESPONSIBILITY:** Co-authored waste management technology screening and selection section of Chapter 2. Management reviewer.

**NAME: RICHARD F. ORTHEN, Jr.**

**AFFILIATION:** Halliburton NUS Corporation

**EDUCATION:** B.S., Chemistry, Emory University, 1979

**TECHNICAL EXPERIENCE:** Thirteen years experience in commercial and defense health physics programs, with an emphasis on effluent and environmental assessment.

**eis RESPONSIBILITY:** Contributed to and reviewed hazardous waste transportation sections in Chapters 2 and 4 and supporting data in Appendix E.

**NAME: KAREN K. PATTERSON**

**AFFILIATION:** Halliburton NUS Corporation

**EDUCATION:** M.A., Biology, Wake Forest University, 1977

B.A., Biology, Randolph-Macon Woman's College, 1973

**TECHNICAL EXPERIENCE:** Twenty-one years experience in technical and management roles in multidisciplinary environmental programs.

**eis RESPONSIBILITY:** Technical Editor. Contributed to Chapters 1, 2, 3, 4, and 5.

**NAME: HOWARD L. POPE**

**AFFILIATION:** U.S. Department of Energy, Savannah River Operations Office

**EDUCATION:** B.S., Mathematics and Physical Science, Tennessee Wesleyan College, 1986

**TECHNICAL EXPERIENCE:** Fifteen years experience in commercial nuclear power and transportation of hazardous wastes.

TE

**eis RESPONSIBILITY:** Document Manager. Principal DOE-SR reviewer of Draft and Final eis.

**NAME: EUGENE M. ROLLINS**

**AFFILIATION:** Halliburton NUS Corporation

**EDUCATION:** M.S.P.H., Health Physics, University of North Carolina, 1976

B.S., Nuclear Engineering, North Carolina State University, 1973

**TECHNICAL EXPERIENCE:** Seventeen years experience in radiological health protection in the commercial nuclear industry and DOE weapons complex.

**eis RESPONSIBILITY:** Prepared traffic and transportation sections and occupational and public health sections in Chapters 3 and 4; and site contamination, and decontamination and decommissioning sections in Chapter 3. Provided technical input to low-level waste sections in Chapter 2, and decontamination and decommissioning and environmental restoration sections in Chapter 4.

**NAME: ROBERT L. SCHLEGEL, PE**

**AFFILIATION:** Halliburton NUS Corporation

**EDUCATION:** M.S., Nuclear Engineering, Columbia University, 1961

B.S., Chemical Engineering, Massachusetts Institute of Technology, 1959

**TECHNICAL EXPERIENCE:** Thirty-two years experience in radiological dose assessments.

**eis RESPONSIBILITY:** Supported the preparation of occupational and public health sections in Chapter 4.

**NAME: MICHAEL SEPTOFF****AFFILIATION:** Halliburton NUS Corporation**EDUCATION:** M.S., Meteorology/Oceanography, New York University, 1968

B.S., Meteorology, City College of New York, 1966

**TECHNICAL EXPERIENCE:** Twenty-nine years experience in meteorology, oceanography, regulatory compliance and permitting, air pollution assessments, risk assessments, and noise and cooling tower assessments.**eis RESPONSIBILITY:** Provided technical input to the atmospheric releases sections in Chapter 4.**NAME: PATRICIA L. SHAW-ALLEN****AFFILIATION:** Halliburton NUS Corporation**EDUCATION:** M.S., Zoology/Ecotoxicology, Oklahoma State University, 1990

B.S., Wildlife Management, University of New Hampshire, 1987

**TECHNICAL EXPERIENCE:** Four years experience in aquatic toxicology/water quality, ecological risk assessments, natural resource management, and ecotoxicology.**eis RESPONSIBILITY:** Provided technical input to ecological resources sections in Chapter 4. Prepared Chapter 5.**NAME: JUDITH A. SHIPMAN****AFFILIATION:** Halliburton NUS Corporation**EDUCATION:** A.A., General Studies, University of South Carolina - Aiken, 1991**TECHNICAL EXPERIENCE:** Seventeen years experience producing environmental-related documentation.**eis RESPONSIBILITY:** Editor. Readability reviewer.**NAME: JOSEPH A. SIGNORELLI****AFFILIATION:** Halliburton NUS Corporation**EDUCATION:** M.S., Engineering, George Washington University, 1963

B.S., Marine Engineering, Webb Institute, 1954

**TECHNICAL EXPERIENCE:** Thirty-one years experience including mechanical engineering for the DOE/Atomic Energy Commission, and the U.S. Navy.**eis RESPONSIBILITY:** Contributed to the preparation of Appendix C.**NAME: G. THOMAS ST. CLAIR, Ph.D.****AFFILIATION:** Halliburton NUS Corporation

**EDUCATION:** Ph.D., Environmental Policy, Michigan State University, 1990

M.S., Environmental Sciences, University of Michigan, 1972

B.S., Biology, Adrian College, 1968

**TECHNICAL EXPERIENCE:** Twenty years experience managing environmental and regulatory projects and programs including technical management and direction as Director of Office of Environmental Services. Experience also includes solid and hazardous waste management; regulatory compliance oversight; environmental assessment and planning, and audits and appraisals; preparation of permit applications; and coordination of public involvement programs.

**eis RESPONSIBILITY:** Prepared unavoidable adverse impacts and irreversible or irretrievable commitment of resources sections in Chapter 4.

**NAME: KEVIN E. TAYLOR**

**AFFILIATION:** PRC Environmental Management, Inc.

**EDUCATION:** M.S., Nuclear Engineering, Georgia Institute of Technology, 1994

B.S., Physics, Clemson University, 1991

**TECHNICAL EXPERIENCE:** One-and-a-half years experience in hydrodynamics, mechanical engineering, thermodynamics, and environmental studies.

**eis RESPONSIBILITY:** Co-authored Appendix D.

**NAME: TOM J. TEMPLES**

**AFFILIATION:** U.S. Department of Energy, Savannah River Operations Office

**EDUCATION:** M.S., Geology, University of Georgia, 1978

B.S., Geology, Clemson University, 1976

**TECHNICAL EXPERIENCE:** Fifteen years experience as a petroleum exploration geologist and geophysicist. Recent experience includes coordinating National Environmental Policy Act document preparation and managing the geoscience and groundwater program for DOE-SR.

**eis RESPONSIBILITY:** DOE-SR reviewer of Draft eis.

**NAME: CATHERINE J. THOMAS**

**AFFILIATION:** Halliburton NUS Corporation

**EDUCATION:** B.A., Journalism, Texas A&M University, 1983

**TECHNICAL EXPERIENCE:** Ten years experience writing and editing for DOE-Savannah River procedures, National Environmental Policy Act documents, and newspapers.

**eis RESPONSIBILITY:** Editor.

**NAME: ALAN L. TOBLIN**

**AFFILIATION:** Halliburton NUS Corporation

**EDUCATION:** M.S., Chemical Engineering, University of Maryland, 1970

B.E., Chemical Engineering, The Cooper Union, 1968

**TECHNICAL EXPERIENCE:** Twenty-two years experience in analyzing radiological and chemical contaminant transport in water resources.

**eis RESPONSIBILITY:** Provided technical input to surface and groundwater resources in Chapter 4.

**NAME: TIMOTHY A. WASHBURN**

**AFFILIATION:** Halliburton NUS Corporation

**EDUCATION:** M.S., Biology, University of Richmond, 1979

B.S., Biology, University of Richmond, 1977

**TECHNICAL EXPERIENCE:** Eighteen years experience in environmental and occupational health physics at commercial and government nuclear facilities.

**eis RESPONSIBILITY:** Prepared transportation sections in Chapters 2 and 4 and supporting appendix data.





# ACRONYMS, ABBREVIATIONS, USE OF SCIENTIFIC NOTATION, AND EXPLANATION OF NUMBER CONVERSIONS

## Acronyms

Aea - Atomic Energy Act

CAA - Clean Air Act

CERCLA - Comprehensive Environmental Response, Compensation and Liability Act

CFR - Code of Federal Regulations

CWA - Clean Water Act

DOE - Department of Energy

ea - Environmental Assessment

eis - Environmental Impact Statement

EPA - Environmental Protection Agency

EPCRA - Emergency Planning and Community Right-to-Know Act

ERPG - Emergency Response Planning Guidelines

FONSI - Finding of No Significant Impact

FR - Federal Register

FY - Fiscal Year

HWMF - Hazardous Waste Management Facility

NEPA - National Environmental Policy Act

PCB - Polychlorinated biphenyl

RCRA - Resource Conservation and Recovery Act

SCDHEC - South Carolina Department of Health and Environmental Control

SDWA - Safe Drinking Water Act

SREL - Savannah River Ecology Laboratory

SRL - Savannah River Laboratory (renamed SRTC)

SRS - Savannah River Site

SRTC - Savannah River Technology Center

### **Abbreviations for measurements**

cfm - cubic feet per minute

cfs - cubic feet per second

g - percentage of gravity (seismology)

g/L - grams per liter

gpm - gallons per minute

L - liter

lb - pound

mg - milligram

μ - micron

μCi - microcurie

μg - microgram

°C - degrees Celsius

°F - degrees Fahrenheit

### **Visualizing units of measure**

1 mg/L - 1 part per million; an example of a unit of one millionth is 1 second in 11.6 days

1 μg/L - 1 part per billion; an example of a unit of one billionth is 1 second in 31.7 years

### **Use of scientific notation**

Very small and very large numbers are sometimes written using "scientific notation" or "E-notation"

rather than as decimals or fractions. Both types of notation use exponents to indicate the power of ten as a multiplier (i.e.,  $10^n$ , or the number 10 multiplied by itself "n" times;  $10^{-n}$ , or the reciprocal of the number 10 multiplied by itself "n" times).

For example:  $10^3 = 10 \times 10 \times 10 = 1,000$

$10^{-2} = 1/(10 \times 10) = 0.01$

In scientific notation, large numbers are written as a decimal between 1 and 10 multiplied by the appropriate power of 10:

4,900 is written  $4.9 \times 10^3 = 4.9 \times 10 \times 10 \times 10 = 4.9 \times 1,000 = 4,900$

0.049 is written  $4.9 \times 10^{-2}$

1,490,000 or 1.49 million is written  $1.49 \times 10^6$

A positive exponent indicates a number larger than or equal to one, a negative exponent indicates number less than one.

In some cases, a slightly different notation ("E-notation") is used, where "x10" is replaced by "E" and the exponent is not superscripted. Using the above examples

$4,900 = 4.9 \times 10^3 = 4.9E+03$

$0.049 = 4.9 \times 10^{-2} = 4.9E-02$

$1,490,000 = 1.49 \times 10^6 = 1.49E+06$

## **EXPLANATION OF NUMBER CONVERSIONS**

The following rules were used in the conversion and rounding of numbers for this eis:

1. Original numbers were converted from metric to English equivalents (or vice versa) according to standard conversion factors.
2. Original numbers were not rounded before they were converted.
3. Converted numbers were rounded to their appropriate level of precision; normally they were rounded to two significant figures including decimals, for numbers below 10,000. Numbers greater than 10,000 were normally rounded to three significant figures.
4. Figures greater than 100,000 were expressed in scientific notation to three significant figures (e.g., 1,450,000 would be expressed as  $1.45 \times 10^6$ ).
5. Metric units are referred to first, with English units in parentheses, regardless of which was the original number.

6. No conversions from English acres were computed for the Ecological Impacts sections in the Summary, Section 2.7, or Chapter 4.

Note: Slight variations in the same number used in different sections may occur because different computer spreadsheet software rounds or truncates numbers differently, or because the analysts rounded the numbers before or after calculations.





## GLOSSARY

activity - See *radioactivity*.

adsorption - The adhesion (attachment) of a substance to the surface of a solid or solid particles.

aggregate - Any of several hard, inert materials such as sand or gravel used for mixing with a cementing material to form concrete, mortar, or plaster.

air dispersion coefficients - Parameters that represent the dispersion of air pollutants with respect to distance from the source.

air quality - A measure of the levels of *constituents* in the air; they may or may not be pollutants.

air quality standards - The prescribed level of *constituents* in the outside air (*ambient air*) that should not be exceeded legally during a specified time in a specified area. (See *criteria pollutant*.)

air sampling - The collection and analysis of air samples for the purpose of measuring pollutants.

alpha particle - A positively charged particle consisting of two protons and two neutrons that is emitted from the nucleus of certain nuclides during radioactive decay. It is the least penetrating of the four common types of radiation (*alpha*, *beta*, *gamma*, and *neutron*).

alpha waste - Waste contaminated with alpha radioactivity measuring 10 to 100 *nanocuries* per gram of waste.

amalgam - An alloy of mercury with another metal that is solid or liquid at room temperature according to the amount of mercury present.

ambient air - The surrounding atmosphere, usually the outside air, as it exists around people, plants, and structures. It is not the air closest to emission sources.

annulus - The space between the two walls of a double-wall tank.

aqueous - Made from, with, or by water.

aquifer - A geologic formation that contains enough saturated, porous material to permit movement of groundwater and to yield groundwater to wells and springs.

ash basin - Settling pond where ash-laden water is retained to allow the ash to settle before the water is discharged.

ashcrete - The solid that results from mixing a liquid waste with cement.

atmosphere - The layer of air surrounding the Earth.

Atomic Energy Commission (AEC) - A five-member commission established after World War II to supervise the use of nuclear energy. The AEC was dissolved in 1975 and its functions transferred to the Nuclear Regulatory Commission (NRC) and the Energy Research and Development Administration (ERDA), which later became the Department of Energy (DOE).

atomic weight - The relative weight of an atom of a chemical element based on the weight of the most abundant isotope of carbon, which is taken to be 12 (or, prior to 1962, the most abundant isotope of oxygen, which was taken as 16).

attainment - A measure of through-put capacity of a facility or system expressed as a percentage.

backfill - Material used to refill an excavation. In this eis, backfill refers to material placed around waste storage containers.

background exposure - See *exposure to radiation*.

background radiation - Normal *radiation* present in the lower atmosphere from cosmic rays and earth sources. Background radiation varies considerably with location depending on elevation above sea level and natural *radioactivity* present in the earth or building materials such as granite.

baseline - Assessment of existing conditions before the addition of pollutants.

becquerel - The international unit of *radioactivity*, equal to one disintegration or other nuclear transformation per second.

benthic region - The bottom of a body of water. This region supports the benthos, a type of life that not only lives on but contributes to the character of the bottom of the body of water.

benzene - A clear, flammable, hazardous, aromatic organic compound (C<sub>6</sub>H<sub>6</sub>); it is a carcinogen.

beta particle - An elementary particle emitted from a nucleus during radioactive decay. It is negatively charged, is identical to an electron, and is easily stopped by a thin sheet of metal.

biodiversity - The variety of life, including all plants and animals within a region.

biological dose - The radiation dose, measured in *rem*, absorbed in biological material.

biological half-life - The time required by the body to eliminate half of an introduced substance through normal channels of elimination.

biota - The plant and animal life of a region.

blackwater - Water in coastal plains, creeks, swamps, and/or rivers that is dark or black due to dissolution of naturally occurring organic matter and certain minerals from soils and decaying vegetation.

blowdown - The withdrawal of water from an evaporating process to maintain a solid balance within specified limits of concentrations of those solids.

borehole - Fiberglass-lined circular hole (9-foot-diameter) augered to a depth of approximately 30 feet that holds forty-two 55-gallon drums of waste grouted in place.

borosilicate glass - A chemically resistant glass made primarily of silica and boron. As a waste form, high-level waste has been incorporated into the glass to form a leach-resistant nondispersible (immobilized) material.

bottomland hardwood forest - Forested wetlands containing a predominance of hardwood species such as oak, hickory, sweetgum, tulip poplar, bald cypress, and blackgum found adjacent to streams and rivers in the southeastern United States.

°C - Degree Celsius.  $^{\circ}\text{C} = 5/9 \text{ X } (^{\circ}\text{F} - 32)$ .

calcareous sands - Sands containing calcium carbonate; when these sands are treated with cold dilute hydrochloric acid, bubbling (effervescing) can be observed, representing the evolution of carbon dioxide.

cancer - A malignant tumor of potentially unlimited growth, capable of invading surrounding tissue or spreading to other parts of the body.

canister - A stainless-steel container in which immobilized radioactive waste is sealed.

canyon - A heavily shielded building used in the chemical processing of radioactive materials to recover special isotopes for national defense or other programmatic purposes. Operation and maintenance are by remote control.

capable - Determination if a geological *fault* has moved at or near the ground surface within the past 35,000 years.

capping - The process of sealing or covering a waste unit with an impermeable medium.

carcinogen - An agent capable of producing or inducing cancer.

carcinogenic - Capable of producing or inducing cancer.

Carolina bay - Shallow depressional wetland area found on the southeastern Atlantic Coastal Plain.

catchment basin - A basin to catch drainage or runoff.

Category 2 species - Plant or animal species for which there is some evidence of vulnerability, but for which presently there is not enough data to support listing as threatened or endangered.

celsius - Of or relating to a temperature scale that registers the freezing point of water as 0°C and the boiling point as 100°C under normal atmospheric pressure.

Citizens Advisory Board - A formally chartered group of local private citizens who provide DOE with a consensus of public opinion on SRS issues.

collective dose - The sum of the individual doses to all members of a specific population.

committed dose equivalent - The dose equivalent calculated to be received by a tissue or organ over a 50-year period after the intake of a radionuclide into the body.

committed effective dose equivalent - The sum of the committed dose equivalents to various tissues in the body.

concentration - The quantity of a substance contained in a unit quantity of a medium (e.g., micrograms of aluminum per liter of water).

condensate - Liquid water obtained by cooling the steam produced in an evaporator system.

confidence level - The certainty of a particular point (measurement, amount, value) being within a statistically determined range.

constituents - Parts or components of a chemical system.

criteria pollutant - Air pollutants for which the U.S. Environmental Protection Agency has established concentration standards; concentrations below the standards do not pose a threat to public health and welfare.

cumulative effects - Additive environmental, health, or socioeconomic effects that result from a number of similar activities in an area.

curie (Ci) - A unit of measure of radioactivity equal to 37,000,000,000 decays per second. A curie is also a quantity of any nuclide or mixture of nuclides having one curie of radioactivity.

daughter - A nuclide (also called decay product) formed by the radioactive decay of another nuclide, which is the "parent."

decay product - See *daughter*.

decay, radioactive - The spontaneous transformation of one nuclide into a different nuclide or into a different energy state of the same nuclide. The process results in the emission of nuclear radiation (alpha, beta, gamma, or neutron radiation).

decommissioning - The removal from service of facilities such as processing plants, waste tanks, and shallow land disposal units, and the reduction or stabilization of radioactive contamination. Decommissioning concepts include:

- Decontaminate, dismantle, and return area to original condition without restrictions.
- Partially decontaminate, isolate remaining residues, and continue surveillance and restrictions.

decontamination - The act of removing a chemical, biological, or radiologic contaminant from, or neutralizing its potential effect on, a person, object, or environment by washing, chemical action, mechanical cleaning, or other techniques.

defense waste - Nuclear waste generated by government defense programs as distinguished from waste generated by commercial and medical facilities.

derived concentration guide (DCG) - The concentration of a radionuclide in air or water that, under conditions of continuous exposure for 1 year by one exposure mode (i.e., ingestion of water, submersion in air, or inhalation), would result in an effective dose equivalent of 100 millirem. DCGs do not consider decay products when the parent radionuclide is the cause of the exposure.

destruction capability - The ability of a process to destroy an undesirable constituent or element.

detrification - Removal of tritium.

direct disposal - Disposal without treatment.

disposal - Placement of waste in a safe place in such a manner that the materials remain permanently isolated from the environment.

dissociate (dissociation) - Separation of chemicals into their elemental or ionic state.

distillate - A liquid product condensed from vapor during evaporation.

dose - The energy imparted to matter by ionizing radiation. The unit of absorbed dose is the *rad*, equal to 0.01 *joules* per kilogram of irradiated material in any medium.

dose conversion factor - Factor used to calculate the cancer risk for a radiation dose.

dose equivalent - A term used to express the amount of effective radiation when modifying factors have been considered. It is the product of absorbed dose (*rads*) multiplied by a quality factor and other modifying factors. It is measured in rem (*Roentgen equivalent man*). (See *effective dose equivalent*.)

dose rate - The radiation dose delivered per unit time (e.g., rem per year).

E-Area vault - Project that consists of several types of facilities (i.e., below-grade concrete structures, on-grade concrete structures within an excavated area) that will store designated waste types (low-activity, intermediate-level tritiated and nontritiated, and long-lived waste) of low-level radioactive waste materials.

ecology - The study of the relationships between living things and their environments.

ecosystem - The community of living things and the physical environment in which they live.

effective dose equivalent - A quantity used to estimate the biological effect of *ionizing radiation*. It is the sum over all body tissues of the product of absorbed *dose*, the quality factor (to account for the

different penetrating abilities of the various types of radiation), and the tissue weighting factor (to account for the different radiosensitivities of the various tissues of the body).

effluent - A liquid discharged into the environment, usually into surface streams. In this eis, effluent refers to discharged wastes that are nonpolluting in their natural state or as a result of treatment.

effluent standards - Defined limits of waste discharge in terms of volume, content of contaminants, temperature, etc.

eis - Environmental impact statement; a legal document required by the National Environmental Policy Act (NEPA) of 1969, for Federal actions involving significant or potentially significant environmental impacts.

eluate - The liquid resulting from removing the trapped material from an *ion-exchange* resin.

Emergency Response Planning Guidelines (ERPG) - Values used to determine potential health effects from chemical accidents.

emission standards - Legally enforceable limits on the quantities and kinds of air contaminants that may be emitted to the atmosphere.

endangered species - Plant or animal species that are threatened with extinction.

endemic - Found only within a certain locality.

engineered trench - Reinforced, concrete-formed, walled 100-foot-long, 50-foot-wide disposal trench with steel covers over each area to minimize rainwater intrusion and direct drainage away from the trench. A leachate collection system installed below the floor of the trench monitors the performance of the disposal cells.

environment - The sum of all external conditions and influences affecting the life, development, and ultimately, the survival of an organism.

environmental justice - The fair treatment of people of all races, cultures, incomes, and educational levels with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment implies that no population of people should be forced to shoulder a disproportionate share of the negative environmental impacts of pollution or environmental hazards due to a lack of political or economic strength.

environmental restoration - The assessment, cleanup, and restoration of sites contaminated with radioactive or hazardous substances during past production or disposal activities.

environmental transport - The movement through the environment of a substance, including the physical, chemical, and biological interactions undergone by the substance.

erosion - The process in which actions of wind or water carry away soil.

exceedance - A value over a prescribed limit.

exothermic - Of or indicating a chemical change accompanied by a release of heat.

Experimental Transuranic Waste Assay Facility (ETWAF) - The assay facility is utilized in alternative A - limited treatment configuration for each of the three waste forecasts.

exposure to radiation - The incidence of radiation on living or inanimate material by accident or intent. Background exposure is the exposure to natural background *ionizing radiation*. Occupational exposure is the exposure to *ionizing radiation* that occurs during a person's working hours. Population exposure is the exposure to a number of persons who inhabit an area.

external radiation - Being exposed to radiation from sources outside your body.

°F - Degree Fahrenheit.  $^{\circ}\text{F} = ^{\circ}\text{C} \times 9/5 + 32$ .

fall line - A line drawn through the falls (or rapids) of successive rivers and roughly defining the area where streams pass from the harder rocks of the Piedmont to the softer rocks of the Coastal Plain.

fallout - The descent to earth and deposition on the ground of particulate matter (which is usually radioactive) from the atmosphere.

fault - A break in the Earth's crust along which movement has occurred.

fauna - Animals.

fecal coliform - Type of bacterial count used to show fecal (bodily waste) contamination levels in water.

filtercake - The dewatered residue from a filter, centrifuge, or other dewatering device.

fiscal year - Period of one year used to calculate financial data. As defined by the Federal government, this eis uses a fiscal year which begins on October 1 and ends on September 30.

fission products - Nuclei from the fission of heavy elements (primary fission products); also, the nuclei formed by the decay of the primary fission products, many of which are radioactive.

floodplain - Level land built up by flowing stream deposition and periodically submerged by floodwater from that stream.

flora - Plants.

gamma rays - High-energy, short-wavelength electromagnetic radiation accompanying fission, radioactive decay, or nuclear reactions. Gamma rays are very penetrating and require relatively thick shields to absorb the rays effectively.

genus/genera - A group of structurally or phylogenetically related species.

geology - The science that deals with the Earth: the materials, processes, environments, and history of the planet, especially the lithosphere, including the rocks and their formation and structure.

greater confinement disposal facility or vaults

Storage facility (boreholes and engineered trenches) that will require minimum maintenance after closure for disposal of the high activity fraction of the low-level solid beta-gamma waste and low-level alpha waste.

gross alpha radioactivity - A measure of total alpha radioactivity.

groundwater - The supply of fresh water in an aquifer under the Earth's surface.

half-life (radiological) - The time in which half the atoms of a radioactive substance disintegrate to another nuclear form. Half-lives vary from millionths of a second to billions of years.

hazardous waste storage facility - Resource Conservation and Recovery Act (RCRA) *interim-status* or permitted temporary holding area of hazardous waste prior to treatment or disposal.

heavy metals - Metallic elements of high atomic mass, such as mercury, chromium, cadmium, lead, or arsenic, that are toxic to plants and animals at known concentrations.

HEPA filter - High-efficiency particulate air filter designed to remove 99.95 percent of the particles down to as small as 0.3 micrometer from a flowing air stream.

high-heat waste - Freshly generated waste that contains a large concentration of short-lived radionuclides from the first extraction cycle of a separations process. High-heat waste is aged to allow radioactive decay to prevent the potential discharge of harmful levels of radiation.

historic resources - The sites, districts, structures, and objects considered limited and nonrenewable because of their association with historic events, persons, or social or historic movements.

hydrolysis - A process of decomposition in which a compound is broken down and changed into other compounds by taking up the elements of water.

hydrostratigraphy - Names used to identify the water-bearing properties of rocks.

immobilization - Conversion of a material into a form that will resist environmental dispersion.

incineration - The burning of waste.

inhibited water - Water treated with chemicals to retard or halt corrosion, especially of metals.

insoluble sludge - A thick layer of various heavy metals and long-lived radionuclides that will not dissolve and that separate out of the waste over time and settle to the bottom of the waste tank.

institutional controls - Actions that limit human activities at or near facilities where hazardous and/or radioactive wastes exist. They may include land and resource use restrictions, well drilling, prohibitions, building permit restrictions, and other types of restrictions.

interim status - The period of operation for facilities that require Resource Conservation and

Recovery Act permits until the permitting process is complete.

internal radiation - Being exposed to radioactive materials inside the body.

investigation-derived waste - Contaminated material resulting from investigation activities at hazardous or radiological waste sites.

ion - An atom or molecule that has gained or lost one or more electrons and has become electrically charged.

ion exchange - Process in which a solution containing soluble ions to be removed is passed through a column of material that removes the soluble ions by exchanging them with ions from the material in the column. The process is usually reversible so that the trapped ions can be collected (eluted) and the column regenerated.

ion-exchange medium - A substance (e.g., a resin) that allows cesium or some other soluble ion to be removed from a solution.

ionization - The process that creates ions. Nuclear radiation, X-rays, high temperatures, and electric discharges can cause ionization.

ionizing radiation - Radiation capable of displacing electrons from atoms or molecules to produce ions.

irradiation - Exposure to radiation.

isotope - An atom of a chemical element with a specific atomic number and atomic mass. Isotopes of the same element have the same number of protons but different numbers of neutrons. Isotopes are identified by the name of the element and the total number of protons and neutrons in the nucleus. For example, plutonium-239 is a plutonium atom with 239 protons and neutrons.

joule - A unit of energy equal to the work done by a force of 1 newton acting through a distance of 1 meter. A newton is the unit of force needed to accelerate a mass of 1 kilogram 1 meter per second per second.

latent cancer fatalities - Deaths resulting from cancer that has become active following a period of inactivity.

leachate - Liquid that has percolated through solid waste or other media and that contains dissolved or suspended contaminants extracted from those materials.

leaching - The process in which a soluble component of a solid or mixture of solids is extracted as a result of percolation of water around and through the solid.

lithosphere - The solid part of the earth composed predominantly of rock.

lithostratigraphy - Description of geological formations based on the physical characteristics of rocks.

loam - A soil textural class with about equal proportions of sand, clay, and silt particles.

long-lived radionuclides - Radioactive isotopes with half-lives greater than approximately 30 years.

long-lived waste - Radioactive waste with a *half-life* which is sufficiently long to remain dangerous beyond the time its retention in a disposal unit can be assured (e.g., carbon-14 has a half-life of 5,730 years and so is considered a longlived waste).

low-activity vaults - On-grade concrete module structures within an excavated area that provides waste storage capacity for waste containers of low-activity waste.

low-heat waste - Second or subsequent extraction cycle waste generated from a separations process. Low-heat waste contains few radionuclides and does not require aging (radioactive decay). Low-heat waste is also generated in reactor areas, the Defense Waste Processing Facility and other SRS production support facilities. (See *high-heat waste*.)

low-income communities - A community in which 25 percent or more of the population is identified as living in poverty.

low-level radioactive waste disposal facility - Disposal facility located within E-Area and consisting of earea Vaults, slit trenches, boreholes, greater confinement disposal vaults, and engineered lowlevel trenches.

lower limit of detection - The smallest concentration/amount of the component being measured that can be reliably detected in a sample at a 95 percent *confidence level*.

macroencapsulate - To seal (e.g., in a box or polymer) a contaminated component so that the contamination is contained.

material substitution - Replacing a hazardous material with a nonhazardous material to reduce the amount of hazardous waste generated.

MAXIGASP - A computer program used to calculate doses or airborne releases of radioactivity to the maximally exposed member of the public.

maximally exposed individual - A hypothetical member of the public assumed to receive the highest calculated dose.

maximum contaminant levels (MCLs) - The maximum permissible level of a contaminant in water that is delivered to a user of a public water system.

migration - The natural travel of a material through the air, soil, or groundwater.

mothball - To place and maintain facilities in a condition practical to restart, conducting only those activities necessary for routine maintenance or to protect human health and the environment.

nano - A prefix meaning one billionth (10<sup>-9</sup>) of any measurement.

National Register of Historic Places - A list maintained by the National Park Service of architectural, historical, archaeological, and cultural sites of local, state, or national importance.

natural radiation or natural radioactivity - *Background radiation*. Some elements are naturally radioactive, whereas others are induced to become radioactive by bombardment in a reactor or accelerator.

NEPA - National Environmental Policy Act of 1969; it requires the preparation of an eis for Federal projects that could present significant impacts to the environment.

neutralization wastewater - Wastewater to which acid or alkali is added to adjust the *pH* to a preferred range.

neutron - An elementary particle with no electrical charge used to bombard the nuclei of various elements to produce fission and other nuclear reactions.

non-alpha waste - Waste contaminated with alpha radioactivity measuring less than 10 nanocuries per gram of waste.

nonprocess water - At SRS, *potable* water.

nonvolatile beta radioactivity - A measure of total beta radioactivity less the volatile isotopes.

NRC - Nuclear Regulatory Commission; the independent Federal commission that licenses and regulates commercial nuclear facilities.

nuclear energy - The energy liberated by a nuclear reactor (fission or fusion) or by radioactive decay.

nuclear radiation - Radiation, usually alpha, beta, gamma, or neutron, which emanates from an unstable atomic nucleus.

offgas - Exhaust emission from an air-emission control unit.

offsite population - In this eis, all individuals located within an 80kilometer (50-mile) radius of SRS.

organic compounds - Chemical compounds containing carbon and usually hydrogen and/or oxygen.

outcropping - Place where groundwater is discharged to the surface. Springs, swamps, and beds of streams and rivers are outcrops of the water table.

outfall - Place where liquid *effluents* enter the environment and may be monitored.

parameter - A characteristic element; any of a set of physical properties whose values determine the characteristics or behavior of something.

particulates - Solid particles small enough to become airborne.

pH - A measure of the hydrogen ion concentration in *aqueous* solution. Pure water has a pH of 7, acidic solutions have a pH less than 7, and basic solutions have a pH greater than 7.

people of color communities - A population that is classified by the U.S. Bureau of the Census as

Black, Hispanic, Asian and Pacific Islander, American Indian, Eskimo, Aleut, or other nonwhite persons, the composition of which is at least equal to or greater than the state minority average of a defined area or jurisdiction.

percent attainment - Percent of the time a facility is available for operations.

permeability - Ability of rock, soil, or other substance to transmit a fluid.

person-rem - The radiation dose to a given population; the sum of the individual doses received by a population segment.

physiographic - Regions classified based on their physical geographic and geologic setting.

pollution - The addition of any undesirable agent to an *ecosystem* in excess of the rate at which natural processes can degrade, assimilate, or disperse it.

pollution prevention - The prevention, rather than control, of pollution using engineering solutions, material substitutions, and procedural changes to reduce the volume and/or toxicity of pollutants produced.

postulated accident - An accident that is forwarded as having occurred to produce the described effects.

potable - Drinkable; for domestic use.

precipitate - A solid (used as a noun). To form a solid substance in a solution by a chemical reaction (used as a verb).

precipitation - The process of forming a precipitate from a solution.

process well/water - At SRS, water used within a system or process and not used as *potable* water.

production well/water - At SRS, water treated and used as *potable* water.

prompt fatality - Death that occurs immediately or within a short time (e.g., a few weeks) as a direct result of an event (e.g., accident).

PSD (Prevention of significant deterioration) - Establishes the acceptable amount of deterioration in air quality. When the air quality of an area meets the standards for a specific pollutant, the area is declared to be in attainment for that pollutant. When the air quality of an area does not meet the standard for a specific pollutant, the area is said to be a nonattainment area for that pollutant. PSD requirements allow maximum increases in ambient air pollutant concentrations (sulfur dioxide, particulates, nitrogen oxide) for construction or modification of facilities, which by definition do not "significantly deteriorate" the existing baseline air quality. (See *criteria pollutant*.)

PUREX - An acronym for plutonium-uranium extraction.

rad - Radiation absorbed dose; the basic unit of absorbed dose equal to the absorption of 0.01 *joules* per kilogram of absorbing material.

radiation - The emitted particles and/or photons from the nuclei of radioactive atoms. A shortened term for ionizing radiation or nuclear radiation as distinguished from nonionizing radiation (microwaves, ultra-violet rays, etc.).

radiation shielding - Reduction of radiation by interposing a shield of absorbing material between a radioactive source and a person, laboratory area, or radiation-sensitive device.

radioactive waste - Materials from nuclear operations that are radioactive or are contaminated with radioactive materials for which there is no practical use or for which recovery is impractical.

radioactivity - The spontaneous decay of unstable atomic nuclei, accompanied by the emission of radiation.

radioisotopes - Radioactive isotopes. Some radioisotopes are naturally occurring (e.g., potassium-40), while others are produced by nuclear reactions.

radiolysis - The decomposition of a material (usually water) into different molecules due to ionizing radiation. In water, radiolysis results in the production of hydrogen gas and oxygen.

recycling - Return of a waste material either to the process that generated the waste or to another process to use or reuse the waste material beneficially; recovery of a useful or valuable material from waste.

rem (*Roentgen equivalent man*) - The unit of dose for biological absorption. It is equal to the product of the absorbed dose in *rads* and a quality factor and a distribution factor.

repository - A place for the disposal of immobilized high-level waste to isolate it from the environment.

resin - An *ion-exchange* medium; organic polymer used for the preferential removal of certain ions from a solution.

Richter scale - A scale of measure used in the United States to quantify earthquake intensity.

risk - In accident analysis, a measure of the impact of an accident considering the probability of the accident occurring and the consequences if it does occur (risk = probability X consequences).

roast, retort, and amalgamate - Heating mercury-contaminated equipment to drive off the mercury as a vapor, collecting and condensing the mercury to a liquid form. Amalgamate - alloying the liquid metal with other metals to create a semi-solid.

Roentgen - A measure of radiation exposure to gamma radiation in air.

runoff - The portion of rainfall, melted snow, or irrigation water that flows across the ground surface and eventually is returned to water bodies. Runoff can carry pollutants or harmless chemical constituents into receiving waters.

saltcake - Concentrated waste in the form of crystallized salts resulting from the evaporation of liquid

high-level waste.

saltstone - Low-radioactivity fraction of high-level waste mixed with cement, flyash, and slag to form a concrete block.

sanitary landfill - A solid-waste disposal facility which is constructed in a manner that protects the environment; waste is spread in thin layers, compacted to the smallest practical volume, and covered with soil at the end of each work day.

satellite accumulation area - Hazardous waste collection points "at or near the point of generation" (as defined by RCRA).

scintillation - A flash of light produced in a fluorescent material by ionizing radiation. A technique used to measure the radioactivity of a sample.

scrub-shrub wetlands - Wetland areas dominated by woody vegetation less than 6 meters (20 feet) tall, including shrubs, young trees, and trees and shrubs that are small or stunted due to environmental conditions.

scrubber - Engineered equipment used to remove *constituents* from a gas stream by absorption and/or chemical reaction.

sedimentation - The settling of excess soil and mineral solids of small particle size (silt) contained in water.

sedimentation pond - Pond constructed specifically to trap excess soil and mineral solids and prevent their deposition in downstream waters and wetlands.

seepage basin - An excavation that receives wastewater. Insoluble materials settle out on the floor of the basin and soluble materials seep with the water through the soil column where they are removed partially by *ion exchange* with the soil. Construction may include dikes to prevent overflow or surface *runoff*.

seismic load - The force due to earthquakes.

seismicity - Refers to earth-movement events, usually earthquakes.

shield - Material used to reduce the intensity of radiation that would irradiate personnel or equipment.

siltation - The act of depositing sediment, as by a river.

slit trench - In this eis, an excavated trench 6 meters wide and 6 meters deep of variable length used to store intermediatelevel, bulky noncontainerized low-level (alpha and beta-gamma) and containerized offsite wastes.

sludge - The precipitated solids (primarily oxides and hydroxides) that settle to the bottom of the storage tanks containing liquid high-level waste.

slurry - A suspension of solid particles (*sludge*) in water.

socioeconomic - The societal and economic configuration of a group of people.

solvent - A substance, usually liquid, that can dissolve other substances.

source reduction - Activities that reduce or eliminate wastes before they are generated.

source term - The initial amount of radioactivity used to calculate exposure and doses to various receptor groups.

standby (cold standby) - Facility is maintained such that it can be brought back into operation with minimum effort.

still bottoms - The sludge that remains in the bottom of a distillation apparatus after the desired product has been evaporated and removed.

storage - Retention of radioactive waste in man-made containment, such as tanks or *vaults*, in a manner permitting retrieval (as distinguished from disposal, which implies no retrieval).

stratigraphy - Branch of geologic science concerned with the description, organization, and classification of layered rock units and associated non-layered rock units.

sump - An impermeable point of collection for liquids in a building or facility.

Superfund - A trust fund established by the Comprehensive Environmental Response, Compensation, and Liability Act and amended by the Superfund Amendment and Reauthorization Act that finances long-term remedial action for hazardous waste sites.

supernatant, supernate - The radioactive layer of highly mobile liquid containing soluble salts; the supernatant remains above the saltcake and/or insoluble sludge in a waste tank.

surface water - All the water on the Earth's surface (streams, ponds, etc.), as distinguished from groundwater, which is below the surface.

suspect soil - Soil that could be radiologically contaminated.

standard pressure and temperature - Air pressure at mean sea level (1 atmosphere); a temperature of 0°C.

tank farm - An installation of (usually interconnected) underground tanks for the storage of high-level radioactive liquid wastes.

toxicity - The quality or degree of being poisonous or harmful to plant or animal life.

turbidity - The degree to which water is muddied or clouded by suspended sediments.

vault - A reinforced concrete structure for storing strategic nuclear materials used in national defense or other programmatic purposes.

vitrification - Incorporation of a material into a glass form.

volatile organic compounds - An organic compound with a vapor pressure greater than 0.44 pounds per square inch at standard temperature and pressure.

volatilized - Caused to pass off as a vapor.

waste acceptance criteria - Criteria put forth by a waste management facility which defines the waste it will accept.

waste certification criteria - Criteria that must be met for transport, treatment, and disposal of waste.

Waste Isolation Pilot Plant - DOE facility located near Carlsbad, New Mexico, built to demonstrate the safe underground disposal of transuranic waste from numerous facilities owned by DOE.

waste minimization - Reduction of waste before treatment, storage, or disposal by source reduction or recycling activities.

water quality standard - Provisions of state or Federal law that consist of a designated use or uses for the waters of the United States and water quality standards for such waters based upon those uses. Water quality standards are used to protect the public health or welfare, enhance the quality of water, and serve the purposes of the Clean Water Act.

wind rose - A map showing the direction and magnitude of the wind.





## DISTRIBUTION LIST

DOE is providing copies of the final eis to federal, state, and local elected and appointed officials and agencies of government; Native American groups; federal, state, and local environmental and public interest groups; and other organizations and individuals listed below. Copies will be provided to other interested parties upon request.

### A. UNITED STATES CONGRESS

#### A.1 Senators from Affected and Adjoining States

The Honorable Paul Coverdell  
United States Senate

The Honorable Ernest F. Hollings  
United States Senate

The Honorable Lauch Faircloth  
United States Senate

The Honorable Bill Frist  
United States Senate

The Honorable Jesse Helms  
United States Senate

The Honorable Sam Nunn  
United States Senate

The Honorable Fred Thompson  
United States Senate

The Honorable Strom Thurmond  
United States Senate

#### A.2 United States Senate Committees

The Honorable Strom Thurmond  
Chairman  
Committee on Armed Services

The Honorable Mark O. Hatfield  
Chairman  
Committee on Appropriations

The Honorable Trent Lott  
Chairman  
Subcommittee on Strategic Forces  
Committee on Armed Services

The Honorable Pete V. Domenici  
Chairman  
Subcommittee on Energy and Water Development  
Committee on Appropriations  
The Honorable Sam Nunn  
Ranking Minority Member  
Committee on Armed Services

The Honorable Robert C. Byrd  
Ranking Minority Member  
Committee on Appropriations

The Honorable J. James Exon  
Ranking Minority Member  
Subcommittee on Strategic Forces  
Committee on Armed Services

The Honorable J. Bennett Johnston  
Ranking Minority Member  
Subcommittee on Energy and Water Development  
Committee on Appropriations

### **A.3 Representatives from Affected and Adjoining States**

The Honorable James E. Clyburn  
U.S. House of Representatives

The Honorable Nathan Deal  
U.S. House of Representatives

The Honorable John J. Duncan, Jr.  
U.S. House of Representatives

The Honorable Lindsey Graham  
U.S. House of Representatives

The Honorable Jack Kingston  
U.S. House of Representatives

The Honorable Cynthia McKinney

U.S. House of Representatives

The Honorable Charlie Norwood  
U.S. House of Representatives

The Honorable James H. Quillen  
U.S. House of Representatives

The Honorable Mark Sanford  
U.S. House of Representatives

The Honorable Floyd Spence  
U.S. House of Representatives

The Honorable John M. Spratt, Jr.  
U.S. House of Representatives

The Honorable Charles H. Taylor  
U.S. House of Representatives

The Honorable Zach Wamp  
U.S. House of Representatives

#### **A.4 United States House of Representatives Committees**

The Honorable Floyd Spence  
Chairman  
Committee on National Security

The Honorable Bob Livingston  
Chairman  
Committee on Appropriations

The Honorable Duncan Hunter  
Chairman  
Subcommittee on Military Procurement  
Committee on National Security

The Honorable John T. Myers  
Chairman  
Subcommittee on Energy and Water Development  
Committee on Appropriations

The Honorable Ronald V. Dellums  
Ranking Minority Member  
Committee on National Security

The Honorable David R. Obey  
Ranking Minority Member  
Committee on Appropriations

The Honorable Ike Skelton  
Ranking Minority Member  
Subcommittee on Military Procurement  
Committee on National Security

The Honorable Tom Bevill  
Ranking Minority Member  
Subcommittee on Energy and Water Development  
Committee on Appropriations

## **B. FEDERAL AGENCIES**

Mr. Don Kilma  
Director, Eastern Office  
Advisory Council on Historic Preservation

Mr. Robert Fairweather  
Chief  
Environmental Branch  
Office of Management and Budget

Ms. Mary Lou Hoinkes  
Acting General Counsel  
U.S. Arms Control and Disarmament Agency

Major General R. M. Bunker  
Division Engineer  
South Atlantic Division  
U.S. Army Corps of Engineers

Mr. David Crosby  
Savannah District  
U.S. Army Corps of Engineers

Mr. Forester Einarsen  
Acting Chief  
Office of Environmental Policy  
U.S. Army Corps of Engineers

Mr. Clarence Ham  
Charleston District  
U.S. Army Corps of Engineers

Colonel R. V. Locurio  
Commander  
Savannah District  
U.S. Army Corps of Engineers

Lt. Colonel James T. Scott  
District Engineer  
Charleston District  
U.S. Army Corps of Engineers

State Conservationist  
Natural Resources Conservation Service  
U.S. Department of Agriculture

Site Coordinator  
U.S. General Accounting Office

Director  
Southeast Region  
National Marine Fisheries Service  
National Oceanic and Atmospheric Administration  
U.S. Department of Commerce

Mr. Larry Hardy  
Area Supervisor  
Habitat Conservation Division  
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## Appendix A

**Table A-1. Thirty-year waste forecast by waste type (volume in cubic meters).**

Table A-1 provides a summary of the three 30-year waste forecasts (expected, minimum, and maximum) for SRS by waste and year. The table supports the discussion of the waste forecasts in Section 2.1. The table was compiled from the *Thirty-Year Solid Waste Generation Forecast for Facilities at SRS (U)* (WSRC 1994a), the *Thirty-Year Solid Waste Generation Maximum and Minimum Forecast for SRS* (WSRC 1994b). Changes in mixed waste volumes between the draft eis and this document as a result of changes between the draft and proposed site treatment plan are presented in Table A-2, and are reflected in the mixed waste totals in this table.

The waste to be managed includes the forecasted generation identified in this appendix plus existing waste volumes in storage; existing waste in storage is included in Section 2.1, Waste Forecasts. To convert volumes to cubic feet, multiply by 35.31.

Year		Liquid high-level waste	Low-level waste	Hazardous waste	Mixed waste	Transuranic waste	
1995	Expected	2,598	17,916	2,418	2,501	650	1949
	Minimum	705	17,906	1,398	1,622	650	1301
	Maximum	2,598	20,028	3,268	3,810	650	4043
1996	Expected	4,317	17,821	1,478	2,539	1,201	2341
	Minimum	1,317	17,816	757	2,074	1,201	1876
	Maximum	4,358	19,136	1,965	4,296	1,754	4642
1997	Expected	3,752	16,574	8,938	1,426	780	1135
	Minimum	1,158	16,448	4,013	938	780	647
	Maximum	4,358	24,395	10,631	2,535	780	2790
1998	Expected	2,432	15,458	40,052	1,682	757	1401
	Minimum	1,240	13,206	32,471	971	487	690
	Maximum	4,321	31,032	40,242	2,734	808	3004
1999	Expected	1,788	15,081	33,375	2,479	720	2198
	Minimum	326	12,970	29,941	935	450	654
	Maximum	2,611	30,481	34,272	3,512	733	3782
2000	Expected	2,175	20,568	6,121	6,302	983	6218

	Minimum	387	12,258	3,400	3,751	135	3667
	Maximum	2,174	39,980	7,334	74,249	87,355a	74519
2001	Expected	2,175	20,354	74,672	5,066	1,064	4999
	Minimum	387	11,553	59,577	2,186	60	2119
	Maximum	2,174	39,884	75,885	73,037	87,355	73307
2002	Expected	857	20,039	8,007	5,111	1,064	5044
	Minimum	387	11,287	1,075	2,136	59	2069
	Maximum	850	39,726	9,220	73,087	87,355	73357
2003	Expected	228	17,509	7,510	29,273	716	29053
	Minimum	387	11,254	1,390	2,351	59	2131
	Maximum	227	47,536	8,723	97,096	87,486	97366
2004	Expected	126	16,856	16,416	9,379	412	9309
	Minimum	387	13,964	18,938	9,082	241	9012
	Maximum	227	51,057	28,550	81,567	87,630	81837

Table A-1. (continued).

Year		Liquid high-level waste	Low-level waste	Hazardous waste	Mixed waste	Transuranic waste	
2005	Expected	126	16,387	16,324	9,023	338	8849
	Minimum	387	12,379	18,050	5,587	114	5413
	Maximum	227	56,663	28,425	80,801	87,450	81071
2006	Expected	126	15,319	16,367	9,177	213	9105
	Minimum	387	12,419	12,555	5,541	114	5469
	Maximum	227	56,193	27,981	16,897	1,139	17167
2007	Expected	126	15,319	16,449	9,189	213	9117
	Minimum	387	12,742	12,634	5,817	118	5745
	Maximum	227	56,193	28,154	16,914	1,139	17184
2008	Expected	126	15,319	16,393	9,232	213	9161
	Minimum	387	12,625	7,087	5,732	185	5660
	Maximum	227	56,193	28,017	16,965	1,139	17235
2009	Expected	126	15,319	16,410	9,245	213	9173
	Minimum	387	11,098	734	2,240	59	2168
	Maximum	227	56,193	24,742	16,982	1,139	17252
2010	Expected	126	15,606	16,401	9,557	285	9468

	Minimum	387	11,098	751	2,279	59	2190
	Maximum	227	56,767	21,359	17,534	1,283	17804
2011	Expected	126	14,996	13,118	9,015	210	8943
	Minimum	387	11,018	720	2,180	58	2108
	Maximum	227	55,548	21,408	16,477	1,132	16747
2012	Expected	126	15,400	9,892	9,418	215	9346
	Minimum	387	11,425	752	2,561	131	2489
	Maximum	227	56,516	21,530	17,387	1,143	17657
2013	Expected	126	15,319	9,943	9,358	214	9286
	Minimum	387	11,098	762	2,264	59	2192
	Maximum	227	56,193	21,557	17,118	1,139	17388
2014	Expected	126	15,299	9,946	9,402	213	9330
	Minimum	387	11,320	784	2,501	61	2429
	Maximum	227	51,052	21,641	17,164	421	17434
2015	Expected	126	15,586	9,973	9,530	284	9593
	Minimum	387	11,078	747	2,141	58	2204
	Maximum	227	51,626	21,623	17,533	532	17954
2016	Expected	126	15,299	9,998	9,307	213	9387
	Minimum	387	11,365	812	2,397	130	2477
	Maximum	227	50,262	21,118	15,106	388	15527
2017	Expected	126	14,976	9,933	9,032	209	9112
	Minimum	387	10,995	741	2,058	57	2138
	Maximum	227	49,617	21,021	14,550	381	14971
2018	Expected	126	13,719	9,015	5,412	147	5492
	Minimum	387	11,076	764	2,151	58	2231
	Maximum	228	50,262	21,123	15,174	388	15595
2019	Expected		13,799	9,029	5,497	148	5576
	Minimum		11,116	768	2,178	58	2257
	Maximum		50,584	21,161	15,478	392	15899

Table A-1. (continued).

Year	Liquid high-level waste	Low-level waste	Hazardous waste	Mixed waste	Transuranic waste
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2020	Expected		13,719	8,925	5,486	147	5548
	Minimum		11,282	791	2,361	129	2423
	Maximum		50,262	20,925	15,242	388	15663
2021	Expected		14,005	9,139	5,733	219	5812
	Minimum		11,398	828	2,441	61	2520
	Maximum		50,835	21,363	15,761	532	16182
2022	Expected		13,719	9,072	5,526	147	5605
	Minimum		11,076	771	2,176	58	2255
	Maximum		50,262	21,180	15,310	388	15731
2023	Expected		13,396	9,054	5,255	143	5334
	Minimum		10,995	763	2,094	57	2173
	Maximum		49,617	21,129	14,754	381	15175
2024	Expected		13,755	9,135	5,609	233	5688
	Minimum		10,959	738	2,085	48	2164
	Maximum		50,447	21,274	15,557	530	15978
Totals	Expected	22,212	474,432	433,503	224,761	12,564	
	Minimum	12,099	367,224	215,512	84,830	5,794	
	Maximum	27,077	1,404,540	676,821	804,627	543,330	

a. The large volumes of transuranic waste are a result of digging up the burial ground.

**Table A-2. Revisions to thirty-year mixed waste generation forecasts by waste classes (volume in cubic meters).**

Table A-2 summarizes the revisions to the mixed waste forecasts that were incorporated in the final eis. These changes were made to align the eis waste forecasts with the 5-year projections for mixed waste generation included in the *SRS Proposed Site Treatment Plan* (WSRC 1995). Table A-2 presents the changes in volume for the various mixed waste classes that have been incorporated in the forecasts. Negative values represent reductions in the current waste forecast from that used in the draft eis analyses. The net effect of these changes (including revised estimates of the amount of mixed waste currently stored at SRS) is an increase in the amount of mixed waste to be managed over the 30-year period of 8,795 cubic meters for the expected and minimum forecasts and 1,554 cubic meters for the maximum forecast (Hess 1995).

Year	Waste classes								
	Inorganic debris	Aqueous liquids	Organic liquids	Organic sludge	Lead	Composite filters	LDR <sup>a</sup>	Organic debris	Mercury

1995	Expected	+5.4	+13	-3	+1.8	+3	-2.4	+213	+320.6	+0.1
	Minimum	+5.4	NC <sup>b</sup>	-3	+1.8	+3	-2.4	+213	+320.6	+0.1
	Maximum	NC	NC	-2.5	NC	NC	NC	NC	NC	NC
1996	Expected	+5.4	NC	-116	+1.8	+1	-3.4	+227	+313	NC
	Minimum	+5.4	NC	-116	+1.8	+1	-3.4	+227	+313	NC
	Maximum	NC	NC	-115	NC	NC	NC	NC	NC	NC
1997	Expected	+5.4	NC	-25	+0.8	+1	-0.4	+227	+313	+0.3
	Minimum	+5.4	NC	-25	+0.8	+1	-0.4	+227	+313	+0.3
	Maximum	NC	NC	-24	NC	NC	NC	NC	NC	NC
1998	Expected	+5.4	NC	-40	+0.8	+5	-0.4	+227	+314	+0.4
	Minimum	+5.4	NC	-40	+0.8	+5	-0.4	+227	+314	+0.4
	Maximum	NC	NC	-39	NC	NC	NC	NC	NC	NC
1999	Expected	+5.4	NC	-40	+0.8	+5	-0.4	+227	+314	+0.5
	Minimum	+5.4	NC	-40	+0.8	+5	-0.4	+227	+314	+0.5
	Maximum	NC	NC	-39	NC	NC	NC	NC	NC	NC
2000	Expected	+5.4	NC	-40	+0.7	+4	-0.4	+30.3	+314	+0.5
	Minimum	+5.4	NC	-40	+0.7	+4	-0.4	+30.3	+314	+0.5
	Maximum	NC	NC	-39	NC	NC	NC	NC	NC	NC
2001	Expected	+5.4	NC	-40	+0.7	+4	-0.4	+14	+314	+0.5
	Minimum	+5.4	NC	-40	+0.7	+4	-0.4	+14	+314	+0.5
	Maximum	NC	NC	-39	NC	NC	NC	NC	NC	NC
2002	Expected	+5.4	NC	-40	+0.7	+4	-0.4	+14	+314	+0.4
	Minimum	+5.4	NC	-40	+0.7	+4	-0.4	+14	+314	+0.4
	Maximum	NC	NC	-39	NC	NC	NC	NC	NC	NC
2003	Expected	+5.4	NC	+112	+0.9	+5	-0.4	+14	+314	+0.4
	Minimum	+5.4	NC	+112	+0.9	+5	-0.4	+14	+314	+0.4
	Maximum	NC	NC	-39	NC	NC	NC	NC	NC	NC
2004	Expected	+5.4	NC	-39	+0.9	+6	-0.4	+14	+314	+0.4
	Minimum	+5.4	NC	-39	+0.9	+6	-0.4	+14	+314	+0.4
	Maximum	NC	NC	-39	NC	NC	NC	NC	NC	NC
2005	Expected	+5.4	NC	+48	+0.9	+6	-0.4	+30.3	+314	+0.4
	Minimum	+5.4	NC	+48	+0.9	+6	-0.4	+30.3	+314	+0.4
	Maximum	NC	NC	-39	NC	NC	NC	NC	NC	NC
2006	Expected	+5.4	NC	-38	+1	+7	-0.4	+14	+314	+0.4
	Minimum	+5.4	NC	-38	+1	+7	-0.4	+14	+314	+0.4
	Maximum	NC	NC	-39	NC	NC	NC	NC	NC	NC

Table A-2. (continued).

Year		Waste classes								
		Inorganic debris	Aqueous liquids	Organic liquids	Organic sludge	Lead	Composite filters	LDR <sup>a</sup>	Organic debris	Mercury
2007	Expected	+5.4	NC	-38	+1	+7	-0.4	+14	+314	+0.4
	Minimum	+5.4	NC	-38	+1	+7	-0.4	+14	+314	+0.4
	Maximum	NC	NC	-39	NC	NC	NC	NC	NC	NC
2008	Expected	+5.4	NC	-39	+1	+7	-0.4	+14	+314	+0.4
	Minimum	+5.4	NC	-38	+1	+7	-0.4	+14	+314	+0.4
	Maximum	NC	NC	-39	NC	NC	NC	NC	NC	NC
2009	Expected	+5.4	NC	-38	+1	+7	-0.4	+14	+314	+0.4
	Minimum	+5.4	NC	-38	+1	+7	-0.4	+14	+314	+0.4
	Maximum	NC	NC	-39	NC	NC	NC	NC	NC	NC
2010	Expected	+5.4	NC	-38	+1	+7	-0.4	+30.3	+314	+0.4
	Minimum	+5.4	NC	-38	+1	+7	-0.4	+30.3	+314	+0.4
	Maximum	NC	NC	-39	NC	NC	NC	NC	NC	NC
2011	Expected	+5.4	NC	-38	+1	+7	-0.4	+14	+314	+0.4
	Minimum	+5.4	NC	-38	+1	+7	-0.4	+14	+314	+0.4
	Maximum	NC	NC	-39	NC	NC	NC	NC	NC	NC
2012	Expected	+5.4	NC	-38	+1	+7	-0.4	+14	+314	+0.4
	Minimum	+5.4	NC	-38	+1	+7	-0.4	+14	+314	+0.4
	Maximum	NC	NC	-39	NC	NC	NC	NC	NC	NC
2013	Expected	+5.4	NC	-38	+1	+7	-0.4	+14	+314	+0.4
	Minimum	+5.4	NC	-38	+1	+7	-0.4	+14	+314	+0.4
	Maximum	NC	NC	-39	NC	NC	NC	NC	NC	NC
2014	Expected	+5.4	NC	-38	+1	+7	-0.4	+14	+314	+0.4
	Minimum	+5.4	NC	-38	+1	+7	-0.4	+14	+314	+0.4
	Maximum	NC	NC	-39	NC	NC	NC	NC	NC	NC
2015	Expected	+5.4	NC	-190	+1	+7	-0.4	+30.3	+314	+0.4
	Minimum	+5.4	NC	-190	+1	+7	-0.4	+30.3	+314	+0.4
	Maximum	NC	NC	-190	NC	NC	NC	NC	NC	NC
2016	Expected	+5.4	NC	-190	+1	+7	-0.4	+14	+314	+0.4
	Minimum	+5.4	NC	-190	+1	+7	-0.4	+14	+314	+0.4
	Maximum	NC	NC	-190	NC	NC	NC	NC	NC	NC
2017	Expected	+5.4	NC	-190	+1	+7	-0.4	+14	+314	+0.4

	Minimum	+5.4	NC	-190	+1	+7	-0.4	+14	+314	+0.4
	Maximum	NC	NC	-190	NC	NC	NC	NC	NC	NC
2018	Expected	+5.4	NC	-190	+1	+7	-0.4	+14	+314	+0.4
	Minimum	+5.4	NC	-190	+1	+7	-0.4	+14	+314	+0.4
	Maximum	NC	NC	-190	NC	NC	NC	NC	NC	NC
2019	Expected	+5.4	NC	+1	+1	+7	-0.4	+14	+314	+0.4
	Minimum	+5.4	NC	+1	+1	+7	-0.4	+14	+314	+0.4
	Maximum	NC	NC	NC	NC	NC	NC	NC	NC	NC
2020	Expected	+5.4	NC	+1	+1	+7	-0.4	+30.3	+314	+0.4
	Minimum	+5.4	NC	+1	+1	+7	-0.4	+30.3	+314	+0.4
	Maximum	NC	NC	NC	NC	NC	NC	NC	NC	NC
2021	Expected	+5.4	NC	+1	+1	+7	-0.4	+14	+314	+0.4
	Minimum	+5.4	NC	+1	+1	+7	-0.4	+14	+314	+0.4
	Maximum	NC	NC	NC	NC	NC	NC	NC	NC	NC

Table A-2. (continued).

Year		Waste classes								
		Inorganic debris	Aqueous liquids	Organic liquids	Organic sludge	Lead	Composite filters	LDR <sup>a</sup>	Organic debris	Mercury
2022	Expected	+5.4	NC	+1	+1	+7	-0.4	+14	+314	+0.4
	Minimum	+5.4	NC	+1	+1	+7	-0.4	+14	+314	+0.4
	Maximum	NC	NC	NC	NC	NC	NC	NC	NC	NC
2023	Expected	+5.4	NC	+1	+1	+7	-0.4	+14	+314	+0.4
	Minimum	+5.4	NC	+1	+1	+7	-0.4	+14	+314	+0.4
	Maximum	NC	NC	NC	NC	NC	NC	NC	NC	NC
2024	Expected	+5.4	NC	+1	+1	+7	-0.4	+14	+314	+0.4
	Minimum	+5.4	NC	+1	+1	+7	-0.4	+14	+314	+0.4
	Maximum	NC	NC	NC	NC	NC	NC	NC	NC	NC

a. LDR = Land Disposal Restriction.

b. NC = No change.

Table A-3. Thirty-year low-level waste forecast by waste classes (volume in cubic meters).

Tables A-3 through A-6 provide a summary of the three 30-year waste forecasts (expected, minimum, and maximum) for SRS by waste type (except high-level waste), treatability group, and year. The table supports the discussion of the waste forecast in Section 2.1. The table was compiled from the *Thirty-Year Solid Waste Generation Forecast by Treatability Group (U)* (WSRC 1994c) and the *Thirty-Year Solid Waste Generation Maximum and Minimum Forecast for SRS*.

Year		Low-level waste classes				
		Long-liveda	Tritiatedb	Bulkc	SoilsSoilsd	Job-control wastee
1995	Expected	63	106	234	988	16,526
	Minimum	63	106	234	978	16,526
	Maximum	63	106	234	3,100	16,526
1996	Expected	40	67	157	878	16,679
	Minimum	40	67	157	873	16,679
	Maximum	40	67	157	2,193	16,679
1997	Expected	1	3	29	630	15,911
	Minimum	1	3	29	625	15,790
	Maximum	1	3	29	8,451	15,911
1998	Expected	7	13	50	328	15,060
	Minimum	7	13	50	322	12,814
	Maximum	7	13	50	16,131	14,831
1999	Expected	2	5	32	294	14,748
	Minimum	2	5	32	288	12,643
	Maximum	2	5	32	15,923	14,519
2000	Expected	120	211	511	1,054	18,673
	Minimum	49	106	403	532	11,169
	Maximum	163	274	570	20,801	18,172
2001	Expected	120	211	511	1,054	18,459
	Minimum	30	75	342	410	10,695
	Maximum	163	274	570	20,801	18,076
2002	Expected	120	211	511	1,054	18,144
	Minimum	29	72	322	383	10,481
	Maximum	163	274	570	20,801	17,918
2003	Expected	120	211	511	1,058	15,610
	Minimum	30	75	342	369	10,437
	Maximum	163	274	570	28,711	17,818
2004	Expected	144	304	540	2,542	13,326
	Minimum	65	222	371	2,806	10,501
	Maximum	204	446	599	31,906	17,902
2005	Expected	127	277	499	2,418	13,067

	Minimum	43	140	332	1,560	10,304
	Maximum	195	6,872	570	31,240	17,786
2006	Expected	136	290	511	2,482	11,900
	Minimum	44	141	342	1,560	10,332
	Maximum	187	6,832	570	30,849	17,755
2007	Expected	136	290	511	2,482	11,900
	Minimum	53	157	374	1,624	10,532
	Maximum	187	6,832	570	30,849	17,755
2008	Expected	136	290	511	2,482	11,900
	Minimum	51	152	351	1,617	10,453
	Maximum	187	6,832	570	30,849	17,755

**Table A-3. (continued).**

Year		Low-level waste classes				
		Long-lived	Tritiated	Bulk	Soils	Job-control waste
2009	Expected	136	290	511	2,482	11,900
	Minimum	30	75	342	371	10,279
	Maximum	187	6,832	570	30,849	17,755
2010	Expected	144	304	540	2,540	12,078
	Minimum	30	75	342	371	10,279
	Maximum	196	6,847	599	31,193	17,932
2011	Expected	126	274	479	2,418	11,700
	Minimum	30	72	322	371	10,223
	Maximum	177	6,816	538	30,462	17,555
2012	Expected	137	293	531	2,482	11,957
	Minimum	39	91	381	429	10,485
	Maximum	197	6,848	602	30,914	17,955
2013	Expected	136	290	511	2,482	11,900
	Minimum	30	75	342	371	10,279
	Maximum	187	6,832	570	30,849	17,755
2014	Expected	136	290	511	2,482	11,880
	Minimum	39	88	354	436	10,403
	Maximum	187	6,832	570	30,849	12,614
2015	Expected	144	304	540	2,540	12,058
	Minimum	30	75	342	371	10,259
	Maximum	196	6,847	599	31,193	12,791
2016	Expected	136	290	511	2,482	11,880
	Minimum	39	89	371	429	10,437
	Maximum	179	6,793	570	30,138	12,582
2017	Expected	126	274	479	2,418	11,680

	Minimum	29	72	322	369	10,203
	Maximum	170	6,777	538	29,751	12,382
2018	Expected	120	211	511	1,060	11,817
	Minimum	30	75	342	369	10,259
	Maximum	179	6,793	570	31,038	12,582
2019	Expected	121	214	531	1,060	11,873
	Minimum	31	77	352	369	10,287
	Maximum	189	6,809	602	30,203	12,782
2020	Expected	120	211	511	1,060	11,817
	Minimum	38	86	351	426	10,381
	Maximum	179	6,793	570	30,138	12,582
2021	Expected	129	225	540	1,118	11,995
	Minimum	40	91	374	434	10,459
	Maximum	188	6,807	599	30,482	12,759
2022	Expected	120	211	511	1,060	11,817
	Minimum	30	75	342	369	10,259
	Maximum	179	6,793	570	30,138	12,582
2023	Expected	110	195	479	996	11,617
	Minimum	29	72	322	369	10,203
	Maximum	170	6,777	538	29,751	12,382
2024	Expected	120	212	525	1,053	11,845
	Minimum	29	70	313	369	10,178
	Maximum	187	6,805	595	30,152	12,737

- a. Includes long-lived spent deionizer resins and other long-lived low-level waste.
- b. Includes tritiated job-control waste, tritiated equipment and tritiated soils.
- c. Includes naval hardware and low-activity equipment.
- d. Includes suspect soils and low-activity soils.
- e. Includes offsite job-control, low-activity job-control, and intermediate activity job-control.

**Table A-4. Thirty-year hazardous waste forecast by waste classes (volume in cubic meters).**

**Table A-4. Thirty-year hazardous waste forecast by waste classes (volume in cubic meters).**

		Hazardous waste classes																	
		Metal debris		Soil	Inorganic debris	Heterogeneous debris	Aqueous liquid	Organic liquid	Glass debris	Aqueous/organic liquid <sup>a</sup>		Bulk	Organic sludge	Lead	Inorganic sludge	Composite filters	Paint waste	Sand/gravel/rock	Organic debris
Year		PCB																	
1995	Expected	105	97	272	150	264	20	20	20	1,174	96	29	59	29	20	10	53	1	
	Minimum	105	97	203	150	265	20	20	20	222	96	29	59	29	20	10	53	1	
	Maximum	5	97	1,128	150	264	20	20	20	1,174	96	29	59	29	20	10	148	1	
1996	Expected	24	51	168	83	152	10	10	10	810	51	15	37	15	10	5	25	1	
	Minimum	24	51	99	83	153	10	10	10	158	51	15	37	15	10	5	25	1	
	Maximum	5	51	623	83	152	10	10	10	810	51	15	37	15	10	5	76	1	
1997	Expected	5	359	5,075	325	508	97	97	160	806	232	114	153	114	97	80	715	1	
	Minimum	5	233	1,864	283	465	55	55	76	141	191	72	112	72	55	38	296	1	
	Maximum	5	359	6,600	325	508	97	97	160	806	232	114	153	114	97	80	885	1	
1998	Expected	32	1,184	29,250	421	456	392	392	781	868	407	394	404	394	392	390	3,893	1	
	Minimum	32	980	24,074	353	387	324	324	644	165	339	326	335	326	324	322	3,212	1	
	Maximum	32	1,184	29,421	421	456	392	392	781	868	407	394	404	394	392	390	3,912	1	
1999	Expected	43	1,036	23,807	459	568	333	333	647	841	408	342	367	342	333	324	3,190	1	
	Minimum	43	956	21,735	432	541	306	306	594	146	381	316	340	316	306	297	2,923	1	
	Maximum	5	1,036	24,648	459	568	333	333	647	841	408	342	367	342	333	324	3,284	1	
2000	Expected	88	233	3,269	198	312	61	61	104	844	143	71	94	71	62	55	453	1	
	Minimum	95	151	2,044	102	161	37	37	70	136	74	40	52	40	38	41	281	1	
	Maximum	88	252	4,161	241	383	67	67	107	844	171	80	108	80	67	54	563	1	
2001	Expected	88	2,288	54,635	883	997	746	746	1,474	907	828	756	779	756	747	639	7,302	1	
	Minimum	88	1,831	44,202	654	706	598	598	1,193	163	630	600	611	600	599	602	5,900	1	
	Maximum	88	2,307	55,527	926	1,068	752	752	1,477	907	856	765	793	765	752	638	7,412	1	
2002	Expected	88	289	4,656	217	330	80	80	141	880	161	89	112	89	80	73	638	1	
	Minimum	85	75	349	69	120	13	13	23	144	44	15	26	15	14	17	53	1	
	Maximum	88	308	5,549	260	402	85	85	144	880	190	98	126	93	85	72	748	1	
2003	Expected	88	273	4,269	212	325	75	75	131	899	156	84	107	84	75	68	587	1	
	Minimum	88	86	574	73	125	16	16	29	147	48	18	29	18	18	21	83	1	
	Maximum	88	292	5,162	255	397	80	80	134	899	185	93	121	93	80	67	697	1	
2004	Expected	92	541	10,878	305	422	164	164	308	961	248	173	197	173	164	156	1,469	1	
	Minimum	92	614	13,691	253	309	192	192	380	174	226	194	206	194	193	196	1,833	1	
	Maximum	92	887	19,967	457	602	278	278	528	961	385	291	320	291	278	264	2,671	1	
2005	Expected	88	536	10,867	296	407	162	162	307	934	242	171	194	171	163	156	1,466	1	
	Minimum	88	584	13,066	239	290	183	183	362	155	214	185	196	185	184	187	1,749	1	
	Maximum	88	883	19,900	451	593	277	277	528	943	382	290	318	290	277	264	2,662	1	
2006	Expected	88	537	10,872	300	413	163	163	307	953	244	172	195	172	163	156	1,467	1	
	Minimum	88	420	8,939	184	236	128	128	252	159	159	130	141	130	129	132	1,199	1	
	Maximum	88	868	19,558	446	588	272	272	518	962	377	285	313	285	272	259	2,616	1	
2007	Expected	92	543	10,864	304	420	163	163	308	1,015	247	173	196	173	164	157	1,467	1	
	Minimum	95	426	8,944	191	248	129	129	254	185	164	131	143	131	130	133	1,201	1	
	Maximum	92	879	19,574	463	615	274	274	520	1,024	387	288	319	288	274	260	2,622	1	
2008	Expected	88	537	10,864	300	413	163	163	307	989	244	172	195	172	163	156	1,466	1	
	Minimum	88	257	4,817	133	188	73	73	143	166	107	75	87	75	75	77	650	1	
	Maximum	88	868	19,558	446	588	272	272	518	998	377	285	313	285	272	269	2,616	1	
2009	Expected	88	537	10,864	300	413	163	163	307	1,008	244	172	195	172	163	156	1,466	1	
	Minimum	88	65	65	66	118	10	10	16	170	41	11	23	11	11	14	15	1	
	Maximum	88	769	17,089	414	556	239	239	452	1,016	344	252	280	252	239	226	2,287	1	

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**Table A-4. (continued).**

		Hazardous waste classes																
Year		PCB	Metal debris	Soil	Inorganic debris	Heterogeneous debris	Aqueous liquid	Organic liquid	Glass debris	Aqueous/organic			Lead	Inorganic sludge	Composite filters	Paint waste	Sand/gravel/rock	Organic debris
										liquid <sup>a</sup>	Bulk	Organic sludge						
2010	Expected	88	530	10,854	289	395	161	161	305	1,069	237	170	191	170	162	155	1,462	1
	Minimum	88	65	58	66	118	9	9	15	196	41	11	23	11	11	14	14	1
	Maximum	88	663	14,537	370	505	205	205	384	1,078	304	217	244	217	205	192	1,946	1
2011	Expected	85	435	8,390	262	372	129	129	240	1,042	208	138	160	138	130	123	1,135	1
	Minimum	85	63	58	65	116	9	9	15	177	40	11	22	11	10	13	14	1
	Maximum	85	667	14,578	376	514	205	205	385	1,051	307	218	246	218	205	193	1,952	1
2012	Expected	92	341	5,926	235	349	97	97	176	1,060	179	106	130	106	98	90	808	1
	Minimum	92	64	63	68	121	10	10	15	181	42	12	23	12	11	13	16	1
	Maximum	92	674	14,617	385	631	207	207	387	1,069	314	220	249	220	207	193	1,953	1
2013	Expected	88	340	5,926	234	347	97	97	175	1,123	178	106	129	106	97	90	808	1
	Minimum	88	65	58	66	118	9	9	15	207	41	11	23	11	11	14	14	1
	Maximum	88	670	14,612	381	523	206	206	386	1,132	311	219	247	219	206	193	1,957	1
2014	Expected	92	345	5,926	238	354	98	98	177	1,096	181	107	130	107	98	91	808	1
	Minimum	92	69	62	71	127	10	10	16	188	45	12	24	12	11	14	16	1
	Maximum	92	681	14,628	397	549	208	208	388	1,105	321	222	253	222	208	194	1,962	1
2015	Expected	92	343	5,932	239	356	98	98	176	1,114	182	107	131	107	98	90	809	1
	Minimum	88	65	58	66	118	9	9	15	192	41	11	23	11	11	14	14	1
	Maximum	92	674	14,650	386	531	207	207	387	1,123	314	220	249	220	207	193	1,962	1
2016	Expected	88	340	5,926	234	347	97	97	175	1,178	178	106	129	106	97	90	808	1
	Minimum	92	68	63	71	127	10	10	16	218	45	12	24	12	11	14	16	1
	Maximum	88	656	14,242	376	517	201	201	376	1,187	306	214	242	214	201	188	1,907	1
2017	Expected	85	336	5,921	229	339	96	96	175	1,150	175	105	127	105	97	90	808	1
	Minimum	85	63	56	65	116	9	9	15	200	40	11	22	11	10	13	14	1
	Maximum	85	652	14,208	371	509	200	200	375	1,159	303	213	241	213	200	188	1,903	1
2018	Expected	88	310	5,185	224	337	87	87	155	1,183	168	96	119	96	87	80	709	1
	Minimum	88	65	56	66	118	9	9	15	211	41	11	23	11	11	14	14	1
	Maximum	88	656	14,242	376	517	201	201	376	1,192	306	214	242	214	201	188	1,907	1
2019	Expected	92	312	5,185	225	339	87	87	156	1,186	169	96	120	96	88	80	709	1
	Minimum	92	66	56	66	119	10	10	16	207	41	11	23	11	11	14	14	1
	Maximum	92	659	14,247	380	525	202	202	377	1,195	309	215	244	215	202	188	1,909	1
2020	Expected	85	299	5,169	208	311	85	85	153	1,204	158	93	114	93	95	79	704	1
	Minimum	88	67	62	70	125	10	10	16	211	44	12	24	12	11	14	16	1
	Maximum	85	646	14,129	359	491	199	199	374	1,213	295	211	237	211	199	187	1,891	1
2021	Expected	95	319	5,191	233	353	88	88	157	1,237	175	98	122	93	89	82	711	1
	Minimum	95	71	61	73	129	10	10	17	222	46	12	25	12	12	15	16	1
	Maximum	95	670	14,296	397	553	204	204	379	1,246	320	218	249	218	204	189	1,918	1
2022	Expected	88	310	5,185	224	337	87	87	155	1,240	168	96	119	96	87	80	709	1
	Minimum	88	65	56	66	118	9	9	15	218	41	11	23	11	11	14	14	1
	Maximum	88	656	14,242	376	517	201	201	376	1,249	306	214	242	214	201	188	1,907	1
2023	Expected	85	307	5,181	219	329	86	86	155	1,258	165	95	118	95	87	80	707	1
	Minimum	85	63	56	65	116	9	9	15	222	40	11	22	11	10	13	14	1
	Maximum	85	652	14,208	371	509	200	200	375	1,267	303	213	241	213	200	188	1,903	1
2024	Expected	92	312	5,186	226	340	87	87	156	1,288	170	97	120	97	88	81	709	1
	Minimum	81	57	56	60	108	8	8	13	232	37	10	21	10	9	12	14	1
	Maximum	92	659	14,251	382	527	202	202	377	1,297	310	215	244	215	202	188	1,910	1

a. Recategorized as aqueous liquids or organic liquids in the in-depth options analysis discussed in Section 2.3.

**Table A-5.** Thirty-year mixed waste generation forecast by waste classes (volume in cubic meters). Changes in the volumes of mixed waste classes between the draft EIS and this document as a result of changes between the draft and proposed site treatment plan are presented in Table A-2 and reflected in the volumes in this table.

		Mixed waste classes																	
Year		PCB	Metal debris		Inorganic debris	Heterogeneous debris	Aqueous liquid	Organic liquid	Glass debris		Organic sludge	Lead	Inorganic sludge	Composite filters	Paint waste	Sand/gravel/rock		Organic debris	Burial ground complex <sup>b</sup>
			Soil													Bulk	LDR <sup>a</sup>		
1995	Expected	2	76	156	119	195	701	79	15	76	25	47	23	16	8	38	403	324	0
	Minimum	2	76	124	119	194	72	79	15	76	25	47	23	16	8	38	403	324	0
	Maximum	2	76	1,027	114	195	894	207	15	76	25	43	23	15	8	113	190	815	0
1996	Expected	1	65	140	104	170	620	94	13	65	23	42	20	14	7	33	807	322	0
	Minimum	1	65	108	104	170	187	94	13	65	23	42	20	17	7	33	807	322	0
	Maximum	1	65	918	99	170	1,118	229	13	65	22	41	20	17	7	98	580	835	0
1997	Expected	1	0	42	6	9	636	171	0	0	2	9	0	1	0	0	227	322	0
	Minimum	1	0	11	6	8	180	171	0	0	2	9	0	1	0	0	227	322	0
	Maximum	1	0	234	1	8	1,138	305	0	0	2	8	0	1	0	0	0	835	0
1998	Expected	1	9	196	12	19	667	159	3	5	5	12	3	4	2	21	243	322	0
	Minimum	1	3	14	10	14	187	157	1	3	3	10	1	2	0	1	243	322	0
	Maximum	1	9	411	7	18	11,755	280	3	5	5	7	3	4	2	24	16	765	0
1999	Expected	1	30	801	16	29	702	166	10	10	12	19	10	11	10	101	227	322	0
	Minimum	1	0	11	6	8	192	156	0	0	2	9	0	1	0	0	227	322	0
	Maximum	1	30	992	11	28	1,217	288	10	10	12	14	10	11	10	101	0	765	0
2000	Expected	2	447	1,476	581	972	809	245	98	388	126	209	123	92	64	300	47	322	0
	Minimum	2	318	927	315	525	252	210	76	209	67	116	65	60	65	173	47	322	0
	Maximum	2	517	4,941	734	1,233	1,349	386	108	493	158	257	156	109	60	704	17	765	62,260
2001	Expected	2	410	553	569	948	825	233	86	375	113	197	111	80	52	177	14	322	0
	Minimum	2	234	97	224	371	237	190	56	146	41	79	39	39	50	46	14	322	0
	Maximum	2	480	4,019	721	1,209	1,370	373	96	480	146	244	144	97	48	581	0	765	62,260
2002	Expected	2	410	553	569	948	854	233	86	375	113	197	111	80	52	177	30	322	0
	Minimum	2	220	97	214	353	241	188	52	138	40	75	37	37	46	45	30	322	0
	Maximum	2	480	4,019	721	1,209	1,404	373	96	480	146	244	144	97	48	581	16	765	62,260
2003	Expected	2	1,130	18,553	909	1,427	1,122	624	326	615	353	437	351	320	292	2,577	14	322	0
	Minimum	2	234	97	224	371	249	341	56	146	41	81	39	39	50	46	14	322	0
	Maximum	2	1,200	22,019	961	1,689	1,678	612	336	720	386	484	384	337	288	2,980	0	759	62,260
2004	Expected	2	554	3,563	646	1,088	954	277	130	440	160	249	158	124	94	586	30	322	0
	Minimum	2	457	5,092	328	565	326	261	127	237	115	159	113	110	118	720	30	322	0
	Maximum	2	743	10,222	838	1,430	1,557	456	180	585	233	336	231	181	130	1,410	16	759	62,260
2005	Expected	2	515	3,478	576	971	973	355	123	394	146	226	144	118	92	560	30	322	0
	Minimum	2	326	2,577	252	428	293	309	87	175	74	112	71	71	81	376	30	322	0
	Maximum	2	718	9,700	801	1,367	1,586	455	175	559	225	323	223	176	127	1,344	0	759	62,260
2006	Expected	2	529	3,521	609	1,024	1,006	271	125	415	153	236	150	119	91	573	30	322	0
	Minimum	2	333	2,577	257	437	299	222	89	179	74	115	72	72	83	377	30	322	0
	Maximum	2	658	8,472	781	1,327	1,600	436	155	540	205	304	203	156	107	1,174	16	759	0
2007	Expected	2	529	3,521	609	1,024	1,034	271	125	415	153	236	150	119	91	573	14	322	0
	Minimum	2	362	2,620	301	508	311	227	94	207	83	129	81	78	86	391	14	322	0
	Maximum	2	658	8,472	781	1,327	1,634	436	155	540	205	304	203	156	107	1,174	0	759	0
2008	Expected	2	529	3,521	609	1,024	1,062	270	125	415	153	236	150	119	91	573	30	322	0
	Minimum	2	344	2,615	284	481	315	225	90	197	80	124	78	75	82	388	30	322	0
	Maximum	2	658	8,472	781	1,327	1,668	436	155	540	205	304	203	156	107	1,174	16	759	0
2009	Expected	2	529	3,521	609	1,024	1,090	271	125	415	153	236	150	119	91	573	14	322	0
	Minimum	2	234	101	224	371	284	189	56	146	41	82	39	39	50	47	14	322	0
	Maximum	2	658	8,472	781	1,327	1,702	436	155	540	205	304	203	156	107	1,174	0	759	0

Table A-5. (continued).

		Mixed waste classes																	
Year		PCB	Metal debris	Soil	Inorganic debris	Heterogeneous debris	Aqueous liquid	Organic liquid	Glass debris	Bulk	Organic sludge	Lead	Inorganic sludge	Composite filters	Paint waste	Sand/gravel/rock	LDR <sup>a</sup>	Organic debris	Burial ground complex <sup>b</sup>
2010	Expected	2	554	3,558	646	1,087	1,123	276	130	440	160	249	158	124	94	585	46	322	0
	Minimum	2	234	101	224	371	290	189	56	146	41	82	39	39	50	47	46	322	0
	Maximum	2	684	8,736	818	1,390	1,741	441	160	565	213	316	211	162	110	1,212	16	759	0
2011	Expected	2	500	3,478	566	953	1,142	266	119	386	144	222	142	113	88	559	14	322	0
	Minimum	2	220	101	214	353	294	187	52	138	40	78	38	37	46	45	14	322	0
	Maximum	2	630	8,171	738	1,256	1,764	430	150	511	197	289	195	151	105	1,131	0	759	0
2012	Expected	2	543	3,521	619	1,042	1,177	273	129	422	154	240	152	121	95	574	30	322	0
	Minimum	2	266	139	267	442	308	195	62	174	50	96	96	45	54	60	30	322	0
	Maximum	2	687	8,515	824	1,399	1,809	441	161	568	214	318	212	182	110	1,189	16	759	0
2013	Expected	2	529	3,521	609	1,024	1,203	271	125	415	153	236	150	116	91	573	14	322	0
	Minimum	2	234	101	224	371	308	189	56	146	41	82	39	39	50	47	14	322	0
	Maximum	2	656	8,472	781	1,327	1,836	436	155	540	205	304	203	156	107	1,174	0	759	0
2014	Expected	2	529	3,521	609	1,024	1,231	271	125	415	153	236	150	119	91	573	30	322	0
	Minimum	2	248	144	257	424	317	193	58	167	48	93	46	43	49	60	30	322	0
	Maximum	2	658	8,472	781	1,326	1,872	436	155	540	205	302	203	156	107	1,174	16	758	0
2015	Expected	2	554	3,558	646	1,087	1,264	124	130	440	160	249	153	124	94	585	30	322	0
	Minimum	2	234	101	224	371	319	37	56	146	41	82	39	39	50	47	30	322	0
	Maximum	2	684	6,736	818	1,389	1,911	290	160	565	213	314	211	182	110	1,212	0	758	0
2016	Expected	2	529	3,521	609	1,024	1,286	119	125	415	153	236	150	119	91	573	30	322	0
	Minimum	2	259	139	262	438	330	42	61	171	49	94	47	44	52	59	30	322	0
	Maximum	2	599	6,991	781	1,287	1,920	265	136	520	186	282	184	137	88	977	16	758	0
2017	Expected	2	500	3,478	566	953	1,311	114	119	386	144	222	142	113	88	559	14	322	0
	Minimum	2	220	97	214	353	329	35	52	138	40	78	37	37	46	45	14	322	0
	Maximum	2	570	6,690	718	1,215	1,948	259	130	491	177	268	175	131	85	934	0	758	0
2018	Expected	2	411	558	569	945	1,305	80	86	376	113	197	111	80	52	178	30	322	0
	Minimum	2	234	97	224	370	337	37	56	146	41	82	39	39	50	46	30	322	0
	Maximum	2	599	6,991	761	1,287	1,988	265	136	520	186	282	184	137	88	977	16	758	0
2019	Expected	2	425	558	580	963	1,335	83	89	383	115	200	113	82	55	179	14	322	0
	Minimum	2	241	97	230	379	344	38	57	149	42	84	40	40	52	47	14	322	0
	Maximum	2	628	7,034	804	1,358	2,028	271	141	549	194	296	192	142	91	991	0	758	0
2020	Expected	2	411	558	569	945	1,361	81	86	376	113	197	111	80	52	178	46	322	0
	Minimum	2	245	134	251	415	352	41	57	164	47	91	45	42	49	57	46	322	0
	Maximum	2	599	6,991	761	1,287	2,056	265	138	520	186	282	184	137	88	977	16	758	0
2021	Expected	2	436	595	607	1,008	1,395	86	91	401	121	209	118	85	54	190	14	322	0
	Minimum	2	263	140	267	442	360	43	61	174	50	96	48	45	53	61	14	322	0
	Maximum	2	624	7,254	799	1,349	2,095	270	141	545	193	295	191	142	90	1,015	0	758	0
2022	Expected	2	411	558	569	945	1,418	81	86	376	113	197	111	80	52	178	30	322	0
	Minimum	2	234	97	224	370	360	38	56	146	41	82	39	39	50	46	30	322	0
	Maximum	2	599	6,991	781	1,287	2,124	265	136	520	186	282	184	137	88	977	16	758	0
2023	Expected	2	382	515	526	874	1,443	75	80	347	104	182	102	74	49	164	14	322	0
	Minimum	2	220	97	214	353	365	36	52	138	40	78	37	37	46	45	14	322	0
	Maximum	2	570	6,690	718	1,215	2,152	259	130	491	177	268	175	131	85	934	0	758	0
2024	Expected	2	420	552	573	952	1,475	82	88	376	113	198	111	81	54	177	30	322	0
	Minimum	2	213	97	209	345	370	35	50	135	39	77	37	36	45	44	30	322	0
	Maximum	2	621	6,991	793	1,340	2,196	269	140	541	192	293	190	141	90	984	16	758	0

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a. Denotes waste that complies with land disposal restriction treatment standards including gold traps, In-Tank Precipitation filters, and safety/control rods.  
 b. Burial ground complex waste is 5 percent bulk; 45 percent soil; 10 percent sand, rock, and gravel; 10 percent metal debris; 1 percent each inorganic debris, glass debris, and organic debris; 25 percent heterogeneous debris; and 2 percent lead.

**Table A-6.** Thirty-year transuranic and alpha waste forecast by waste classes (volume in cubic meters).

Year		Transuranic and alpha waste classes			
		Low-activity with processing <sup>a</sup>	High-activity <sup>b</sup>	Low-activity without processing <sup>c</sup>	Burial ground complex <sup>d</sup>
1995	Expected	133	439	78	0
	Minimum	133	439	78	0
	Maximum	133	439	78	0
1996	Expected	203	882	116	0
	Minimum	203	882	116	0
	Maximum	286	1,297	171	0
1997	Expected	124	595	61	0
	Minimum	124	595	61	0
	Maximum	124	595	61	0
1998	Expected	141	545	72	0
	Minimum	90	351	47	0
	Maximum	149	584	74	0
1999	Expected	135	517	68	0
	Minimum	84	323	43	0
	Maximum	138	528	67	0
2000	Expected	179	710	93	0
	Minimum	21	100	14	0
	Maximum	184	759	98	86,314
2001	Expected	195	768	101	0
	Minimum	10	44	6	0
	Maximum	184	759	98	86,314
2002	Expected	195	768	101	0
	Minimum	9	43	6	0
	Maximum	184	759	98	86,314
2003	Expected	129	518	68	0
	Minimum	9	44	6	0
	Maximum	204	857	111	86,314
2004	Expected	67	305	40	0
	Minimum	37	180	24	0
	Maximum	226	965	125	86,314
2005	Expected	56	249	33	0
	Minimum	18	85	11	0
	Maximum	199	830	107	86,314
2006	Expected	33	160	21	0
	Minimum	18	85	11	0
	Maximum	199	832	108	0
2007	Expected	33	160	21	0
	Minimum	18	88	12	0
	Maximum	199	832	108	0
2008	Expected	33	160	21	0
	Minimum	28	138	18	0
	Maximum	199	832	108	0
2009	Expected	33	160	21	0
	Minimum	9	44	6	0
	Maximum	199	832	108	0
2010	Expected	43	213	28	0
	Minimum	9	44	6	0
	Maximum	221	940	122	0

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**Table A-6.** (continued).

Year		Transuranic and alpha waste classes			Burial ground complex <sup>d</sup>
		Low-activity with processing <sup>a</sup>	High-activity <sup>b</sup>	Low-activity without processing <sup>c</sup>	
2011	Expected	32	157	21	0
	Minimum	9	43	6	0
	Maximum	198	827	107	0
2012	Expected	33	160	21	0
	Minimum	20	98	13	0
	Maximum	200	835	108	0
2013	Expected	33	160	21	0
	Minimum	9	44	6	0
	Maximum	199	832	108	0
2014	Expected	32	159	21	0
	Minimum	10	45	6	0
	Maximum	64	315	42	0
2015	Expected	43	213	28	0
	Minimum	9	43	6	0
	Maximum	80	398	53	0
2016	Expected	32	159	21	0
	Minimum	20	97	13	0
	Maximum	59	291	39	0
2017	Expected	32	156	21	0
	Minimum	9	42	6	0
	Maximum	58	285	38	0
2018	Expected	23	110	15	0
	Minimum	9	43	6	0
	Maximum	59	291	39	0
2019	Expected	23	110	15	0
	Minimum	9	43	6	0
	Maximum	59	293	39	0
2020	Expected	23	110	15	0
	Minimum	20	96	13	0
	Maximum	59	291	39	0
2021	Expected	33	163	22	0
	Minimum	10	46	6	0
	Maximum	80	398	53	0
2022	Expected	23	110	15	0
	Minimum	9	43	6	0
	Maximum	59	291	39	0
2023	Expected	22	107	14	0
	Minimum	9	42	6	0
	Maximum	58	285	38	0
2024	Expected	35	174	23	0
	Minimum	8	36	5	0
	Maximum	80	397	53	0

- a. Includes mixed alpha job-control waste, mixed transuranic job-control waste, and transuranic job-control waste with less than 0.5 curies per drum.
- b. Includes mixed transuranic equipment, transuranic equipment, mixed transuranic job-control waste with more than 0.5 curies per drum, transuranic job-control waste with more than 0.5 curies per drum, and remote handled transuranic and mixed transuranic wastes.
- c. Includes alpha job-control waste.
- d. Includes 50 percent mixed alpha job-control waste; 40 percent mixed transuranic job-control waste less than 0.5 curies per drum; and 10 percent mixed transuranic job-control waste greater than 0.5 curie per drum.

curie per drum.

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